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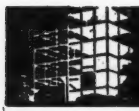

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▶ The Constitution and By-Laws of the Society state, "An individual member who has been in good standing for twenty-five (25) years or more, who has reached the age of sixty-five (65) years, and who has retired from active professional life, may, upon written request, be designated as a life member by vote of the General Council, and shall thereafter be exempt from payment of dues." Long-time, loyal members should request such status instead of resigning. Many members do wish to continue their financial support of the Society after their retirement and to them we are indeed grateful. We try to prevent resignations of long-time members by calling their attention to the life membership provisions, but we can't be sure we catch everyone, particularly if they just stop paying dues and say nothing to us.

▶ All of you received the Yearbook Information Card in September. Did you return it? Did you inform us of your change of address and change of title? The correctness of addresses and titles are important aspects of the Yearbook information and if *you* don't send them to us the value of the Yearbook is lessened. *Maybe* we can still get a change made if you hurry, but remember we want the February Yearbook issue to come out in February and can't wait for many late changes.

▶ At the Annual Meeting ECRC was granted permission by the General Council to establish an annual award for outstanding research. The first award will be made at the 1956 Annual Meeting. A gift from outside ASEE is being sought for the award, but pending such a grant the necessary funds will come from the ECRC reserve fund. The award is to consist of a gold medal and a certificate. As soon as details of the method of selection, etc. are determined they will be published. This award appropriately fits into the pattern of the other Society awards—Lamme, Westinghouse, and McGraw.

▶ The General Council also granted ECRC approval to seek funds from the National Science Foundation for a study to determine the research needs of the engineering sciences and the ways by which they shall be met. Most of the other branches of science have made or are making such studies and it is appropriate for engineering to make the same type of study. It is to be an ASEE project covering a two-year period of time and costing $40,000. The work will be directed by ECRC personnel and, among other things, will consist of visits to universities and research laboratories.

► In the October issue of the JOURNAL there were brief announcements about the Lamme, Westinghouse and McGraw awards. Preparing adequate material to accompany a nomination requires much time and effort. If you have a candidate for an award in mind, active work on the collection of material should begin now. The committees making the selections have an unenviable task and their decisions aren't always easy to make. We should cooperate by having all material in good condition and submitted as early as possible.

► All YETs should begin thinking about their paper contest. Each Section chooses a winner and their papers are then judged by the national judging committee. Last year a few sections did not submit a paper! That is most unfortunate and shouldn't happen again. Section officers and deans, as well as YET organizations, should promote participation. The first place winner receives $200 and second place $100. There also is an honorable mention. The awards are made at the Annual Banquet, the winning papers are presented at the Annual Meeting, and the winners' institutions are requested to pay their expenses to the Annual Meeting. In addition, all papers submitted for the national competition are considered for publication in the JOURNAL OF ENGINEERING EDUCATION.

► Questions are frequently asked about Section and committee chairmen. The former are listed in each issue of the JOURNAL on the Section Meetings page; the latter always appear in the October issue of the JOURNAL. The representatives on the General Council and the officers of the Society always are listed on page two (2) of each JOURNAL. It is hoped a complete list of ASEE committee members will appear in the December JOURNAL in addition to the February Yearbook issue.

► The minutes of the meetings of the Executive Board and General Council are on pages 290 and 294. These are essentially as they appear in the records of the Society, except that most of the committee reports attached as appendices are not included. Most of these reports are being published separately in order to attach appropriate significance to their contents.

► The initial printing of 1000 Educational Aids is sold out. A second printing of 1000 is now available—so, send in your dollar and you'll get your copy. Also, is there a need for another volume covering other branches of engineering? You who are doing the actual teaching must determine this need. Some money is available for additional work. As soon as the need and the desire are indicated the Executive Board will appoint a new committee.

► Plans are being developed for four Summer Schools for 1956. The Divisions sponsoring them are Civil Engineering, Drawing, Humanistic-Social, and Mechanics. All are being planned for about the time of the Annual Meeting. The continued desire for these schools during the past few years indicates their value and the desire of those in the particular areas of engineering to get together and seriously "talk shop" about common problems and practices. Every Division could profitably devote a summer school to a consideration of the report on Evaluation of Engineering Education.

► The Relations With Industry Division is holding its annual College-Industry Conference at Marquette University on January 25 and 26. The theme of the meeting will be "The Humanistic-Social Approach as an Aid to Engineering." Marquette is celebrating its 75th anniversary and the holding of this Conference is part of their celebration. This meeting is becoming more important each year; there is no doubt about the growing interest of industry in education.

▶ Plans are being made to ask all Sections to publicize the 1956 Annual Meeting at Iowa State at their meetings. It is hoped the Section officers and host institutions will cooperate with Lowell O. Stewart and his committee at Iowa State. This is a step in the coordination of Section Meetings and the Annual Meeting, something which seems desirable. *"Aim for Ames in '56"* for the week of June 25-29!

▶ Don't forget about the "Nuclear Engineering and Science Congress" at Cleveland, Ohio on December 12–16. Engineers Joint Council, of which ASEE is a participating society, is coordinating the efforts of 26 Engineering and Scientific Groups interested in the subject. 292 technical papers will be presented. See page 268 for more details.

W. LEIGHTON COLLINS
Secretary

Humanistic-Social Stem in Engineering Education Bibliography

The staff of the Cooper Union Library has prepared a completely revised and more comprehensive edition of the bibliography, *The Humanistic-Social Stem in Engineering Education.* Chronologically, the bibliography cover this area from 1876 through May, 1955. It is especially applicable to the fields of chemical, civil, electrical, and mechanical engineering. One complimentary copy of the bibliography will be sent to each ASEE member who will tear off and complete the form below and send it to Joseph N. Whitten, Librarian, The Cooper Union, Cooper Square, New York 3, New York.

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Please send me a copy of the 1955 revised edition,
The Humanistic-Social Stem in Engineering Education.

Name ..... Title .....

Address .....

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PROFESSOR EDWIN C. MCCLINTOCK

Meet Professor Edwin C. McClintock, New Journal Editor

Professor Edwin C. McClintock will succeed Professor C. E. Watson as Editor of the JOURNAL OF ENGINEERING EDUCATION effective October 1, 1955. His appointment fills the gap left by the untimely death of Professor Lisle A. Rose, who was to have been the new editor. Due to the long-range production schedule of the JOURNAL, Professor Watson will plan and supervise all issues of the JOURNAL through the December, 1955 issue. Professor McClintock's editing will begin with the January, 1956 JOURNAL.

The new editor, formerly on the faculty of the University of Virginia, recently accepted an appointment at the University of Illinois as Professor of General Engineering, Director of Engineering Information and Publications, and Engineering Experiment Station Editor. Professor McClintock will spend one-fifth of his time as editor of the JOURNAL and four-fifths of his time on his other duties.

Professor McClintock was born February 3, 1914, at Monterey, California. His family moved to the East where he received his early education in Washington, D. C., schools. He earned his B.A. at the University of Virginia, majoring in literature, speech, and social theory. He continued with graduate studies at the University of Virginia.

In 1939, he was married to Elizabeth Kepner of Charlottesville, Virginia. They have two sons, Richard Clare, 11, and Robert White, 8.

In 1940, after holding concurrent part-time instructorships in speech and English, Professor McClintock was appointed instructor in English in the unique humanities program for the School of Engineering at the University of Virginia. He rose to Acting Professor and Acting Head of the Department of English in the School of Engineering in 1951. He was in charge of editing catalogues and official publications for the University for several years. After training at the Library of Congress, he was placed in charge of developing and administering an engineering and science-technology library at the University.

After joining the ASEE in 1939, he became active in the English and Social-Humanistic Divisions. He has been a member of the Engineering School Libraries Committee and is a member of the Publications Committee. He is a member of Phi Beta Kappa, Omicron Delta Kappa, and Delta Sigma Rho. His professional connections include the Special Libraries Association, American Library Association, Association of Special Libraries, American Business Writers Association, College English Association, Society of Professional Writers and Editors, and Illuminating Engineering Society.

Among his publications are papers on training scientists and engineers for industrial and special library techniques, research resources of British metallurgical libraries, and two books (in the process of publication) on grammar, composition, and advanced scientific writing and speaking.

Professor McClintock has been concerned with the development of humanities courses in engineering schools, with the encouragement of secondary school interests in science or technology, and with improved methods of guidance for science-minded school or college students. He has been active in the Junior Academy of Science work in Virginia and chairman of the State Science Talent Search. With J. L. Vaughan, another ASEE member, he recently developed a pioneer course for secondary school teachers exploring scientific resources and communications methods helpful to science teaching in secondary schools.

Education for Research in Industry*

By CHALMER G. KIRKBRIDE

President, Houdry Process Corporation, Philadelphia, Penna.

Before we get involved in trying to determine what should be done to prepare the young engineer for industrial research, let us review briefly the history of the development of industrial research. Then let us consider what qualities we would like to develop in the embryo researcher.

What is research? There are many millions of dollars spent each year on work that is classified by some as industrial research, but I would not so classify it.

Research is defined by Webster as diligent, studious inquiry or examination in seeking new facts or undiscovered principles. This is good but I would want to stipulate also that research is done in the mind rather than in the laboratory or library. It is a mental attitude that distinguishes it from mere scientific or technical work. Experimental work is done in research merely to assist and verify.

The use of the experiment to assist in research was scorned by the Greek philosophers. At that time the intellectuals preferred to accept some untested and even invalid premise as a basis from which one could philosophize to the construction of completely new systems without the aid of experiment. Experiment was scorned because that was likened to the practice of slaves. The acceptance of experiment as an aid was, therefore, too much for the intellectuals at that time. Without trying to be facetious, I suspect that another reason for scorning the experimental method may have been that the intellectuals did not want their theoretical conclusions confused by the facts. I might say that even today there are many pseudo researchers of that attitude who classify themselves as intellectuals.

It was not until near the end of the sixteenth century before the experimental method was adopted as an aid in the study of nature. Galileo and Francis Bacon perhaps were the first to advocate the use of experimental methods in research. During the past three and a half centuries the use of experimentation in research has developed at a phenomenal rate.

Prior to the early part of the twentieth century, industrial research was almost non-existent. It was carried on by individual inventors. But after World War I, industrial research developed exponentially with time. Furthermore, this growth has taken the direction of organized research in which investigations are conducted by teams of inventors or researchers as opposed to individuals.

Accomplishment by team-work far exceeds that attainable by a like number of individual investigators of equal competence. Of course, thinking is individual in nature but it is catalyzed by team effort if the team is managed properly. With proper management, a closely knit team can be developed, the members of which stimulate creative thinking in each other toward a common objective. Unless this is attained, the group will work as separate individuals that do not catalyze each other.

Since research is done in the mind rather than in the laboratory, it is essential that all conditions be favorable to the stimulation of team effort. Worried minds are not productive in research.

* Presented at the General Session, Annual Meeting of ASEE, Penn State University, June 22, 1955.

Now, let us consider the qualities desired in the young engineer entering industrial research. Immediately we can conclude from the discussion thus far that he should have the ability to work in cooperation with others. One of the problems often encountered with the young graduate is to fit him into a team with other highly trained engineers and scientists. Too often, his training in school has neglected the development of his ability to work in a team.

Also, too often, his training in school has been too much in the direction of robot intellectuality—too much standardization, too much devotion to the assimilation of factual knowledge at the expense of learning how to think imaginatively. It is unfortunate that we have not been able to avoid the repression of imagination and ingenuity of students in our mass educational methods. Mass education processes are based on classifying students into groups and if a chap happens not to fit into one of these groups he often is labeled as stupid and cast by the wayside even though he may be highly intelligent. This process of repressing the student's imagination and ingenuity is started in grammar school and continues through secondary school and into college work. It is one of the unfortunate faults of mass education methods.

The present day graduate is strong in being able to carry out a mathematical solution to a problem after the problem has been defined for him. But he is pitifully weak in recognizing and defining the limits of a problem. He could stand considerable strengthening in this regard.

As other desirable qualities in the young engineer, he should have the ability to study and in addition let us hope that he has developed the habit of studying.

He should be of high integrity. He should be courageous. He should have self-confidence. He should have energy. He should be determined. He should have a deep sense of responsibility. He should be able to think creatively.

But the most desirable quality of all is sound judgment. Some are born with this quality, but most people must develop it if they ever get it at all.

Yes, all those qualities are desirable for our young graduate entering industrial research. However, these same qualities are desirable for the young engineer entering almost any other field of engineering practice. Hence, I come to the conclusion that the student should not be trained specifically for industrial research. Of course, the aptitude of the young man for industrial research must be favorable but that is another matter.

I want to make it clear, then, that I am opposed to any educational program that attempts to prepare an engineer for a specific niche in life. It is unfortunate that the interests of so many students are encouraged only down narrow paths so that in effect they are led into ruts from which many of them never emerge. Other interests these students may have had are too often allowed to go undeveloped and finally to die.

It is essential, in my opinion, that the student be trained so that he may enter his professional practice with a maximum of self-confidence and courage. A broad intensive training is needed because the young engineer will not be able to select the obstacles that fall in his path. He must be able to endure hardships and disappointments in his work because it is during periods of hardship that we learn the most. We must be conditioned by hardships to prepare us for greater responsibilities.

Hence, what I have to say about the academic training needed to prepare the young engineer for industrial research will be equally applicable to prepare him for many other fields of engineering practice.

Broad Training Proposed

A proper objective of education is first to develop well balanced men and women who not only are able to fit into society but also who have the ability to lead society. This objective is just as much a responsibility of engineering education

as it is of other branches of education such as law, literature, theology and journalism.

The engineer should not be trained specifically for industrial research. His education should not be given undue emphasis even though his immediate interests may lie in that direction.

It is true that research is a field for young men. On the average their ability to think creatively increases until the age of 25 to 30 years. Then it seems to level off for the next five to ten years. After that the decline in creativity takes place at an increasing rate.

Furthermore, the interest of the engineer in research seems to go through somewhat the same type of change. John Mills in his book, "The Engineer In Society," showed how the aptitude of the engineer for research declines as he gets older. If the total interests of the well adapted young research engineer is divided on the basis of a scale of 100 among ideas, things, people, and symbols it would be something like 60 for ideas, 25 for things, 10 for people and 5 for symbols. However, as the engineer grows older his interests change so that his greatest interest first turns to things, then to people and finally to symbols. Therefore, the young research engineer will probably pass on into other fields of enginering practice such as administration, design, construction, manufacturing, and sales. It would be unfortunate indeed if his education had not been sufficiently broad so as to be of value to him in these later endeavors.

The engineer should be given broad fundamental training which is applicable to all fields of engineering practice. The engineer of tomorrow must grapple with problems that the engineer of today has been unwilling if not unable to face. The engineer, together with his scientist counterpart, is primarily responsible for the creation of the American economy. Nevertheless, the modern engineer has devoted no significant effort toward directing this economy. He has been content to leave by default the job of directing to lawyers, labor negotiators, politicians, news commentators, economists, military leaders, and others who know less about his creation than he. The same type of mind that created the economy is needed to direct it. In the formation of our Republic, such men as Washington, Franklin and Jefferson were perhaps the outstanding leaders. These men had a knowledge of science and engineering as it existed at that time, in addition to a knowledge of law. And of greater importance they had the scientific approach to the solution of problems. The engineer of tomorrow must take a major share of the direct responsibility in directing the destiny of our Nation comparable to that taken by Washington, Franklin and Jefferson.

Training in Inductive Thinking Needed

The present day training given the student engineer, even through the doctorate, is concentrated (1) in the assimilation of factual knowledge, and (2) in the application of deductive logic. Rarely is any significant attention devoted to the application of inductive logic.

Now before going further, I want to make certain that you understand what I mean by deductive and inductive thinking. Deductive thinking is the process of reasoning from the general to the particular. Therefore, it involves reasoning from a general principle or law to a specific situation. Inductive thinking, on the other hand, is the process of reasoning from the particular to the general. Therefore, it involves reasoning on the basis of specific situations or random facts to a general principle or law.

As an example, the first, second and third laws of thermodynamics were arrived at by inductive thinking. They were established on the basis of countless observations of specific situations. There is no proof for these laws other than experience. However, once these laws are accepted the entire subject of thermodynamics is developed by use of deductive thinking. Inductive thinking is not infallible but the process of deductive thinking is rigorous. If a proposition is true

universally, it is true in any specific case. The maximum attainable by inductive reasoning, on the other hand, is only a high degree of probability. It is highly probable that the sun will rise and set tomorrow but we cannot prove that it will.

Even though inductive reasoning is not rigorous, it is an invaluable process of thinking in all fields of engineering practice, but particularly in the field of research. Inductive reasoning requires a great deal more applied imagination and ingenuity than does deductive reasoning. Inductive thinking has been ignored, relatively speaking, in our educational processes even though it has been the method of thinking by which general principles and laws of greatest import have been established. Its usefulness derives from the understanding that there are invariable effects produced by natural causes. Observation of these effects leads to discovery of apparent uniformities or relationships which provide the basis for establishing universal laws or general principles.

It was primarily deduction that helped to develop Euclidean geometry and the Scholastic philosophy. But it was induction that produced the Copernican system, Newton's principles of gravitation and motion, and Darwin's theory of evolution. The great scientists of the past who are recognized today were invariably masters at inductive thinking. I do not recall a single one that gained recognition by his ability at deductive reasoning. It was their inductive reasoning that distinguished them from the "run of the mill" scientist.

Perhaps it would be well at this time to determine why inductive reasoning has been given so little attention in education. Inductive reasoning is a method of thinking of free people. As long as education is to serve autocratic state or church rulers, there is no place or need for inductive reasoning. The general principles and laws will be determined, not by inductive reasoning, but by decree of the rulers. The old Greek or Roman conception of education was to serve the state. In more modern times, Hitler and Stalin, among others, followed the same line.

In early Christian education, "catechumenal" and "catechetical" schools were established to teach and defend the dogmas of the church. However, at the end of the Middle Ages a new class of people came into being which was called merchants. They initiated vocational schools so that their children could follow their father's particular trades. Thus, appeared the guild and town schools with vocational rather than religious purposes. This radical change was introduced by the Renaissance challenging the church's control of education together with the Luther Reformation which proposed education for all the people and held that everyone should read and interpret the Bible "according to his own understanding."

At this point in the history of education, a place was made not only for deductive reasoning, attributed to Aristotle (384–323 B. C.), but also for inductive reasoning, attributed to Francis Bacon (1561–1626). Bacon understood the danger of prejudices, the value of scientific knowledge, and the necessity for clear and accurate thinking leading to hypotheses. Even so, there is reasonable doubt that he had any significant ability for inductive reasoning. His contemporary, Galileo, probably far excelled him at inductive reasoning but it was Bacon who had the influence on education and influenced it in the direction of inductive processes.

For the past three centuries, educators and philosophers have been trying to determine what should be taught in our schools and what are the principles of thinking. Fortunately, Bacon's basic ideas seem to have prevailed. Inductive reasoning in a free society appears *to be ready* for intensive development not only in the scientific and engineering fields but also in the political, social and economic life of the United States.

The engineer in research uses both deductive and inductive thinking. However, the differences between the creative abilities of individuals in research is reflected

probably more than anything else by the differences in their abilities to use inductive reasoning. The most creative may not be the strongest at deductive thinking nor the best posted in factual knowledge but he will surpass all others at inductive reasoning.

In research the engineer often employs unfounded hypotheses to assist him in his creativity. He makes observations of end results and he often tries to determine the path that was followed in reaching these end results. By using inductive reasoning with applied imagination, the researcher is able to set up an hypothesis which *could* explain by deductive reasoning the observed end results. Then the researcher goes about the testing of this unfounded hypothesis under other conditions. He will proceed with this method of attack modifying the hypothesis by the use of inductive thinking and imagination as he obtains new facts that show the need for modification. Both deductive and inductive reasoning are essential for creativity but inductive reasoning is the determining factor and certainly permits the greater opportunity for applied imagination and ingenuity.

The primary distinction between judicial thinking and creative thinking is that judicial thinking is almost devoid of inductive reasoning. Judgments are developed from the facts primarily by means of deductive thinking. The general principles or laws have been established and interpreted previously.

On the other hand, in creative thinking, facts serve merely as a starting point from which one reasons by inductive processes assisted by deductive reasoning to new principles and new and untried situations. This requires applied imagination and ingenuity particularly for the inductive processes.

Certainly the engineer entering industrial research should be well trained in inductive as well as deductive reasoning. However, the way our present day engineering curricula are presented, insufficient attention is devoted to the development of the student's ability to think inductively. On the other hand, excellent intensive training is given the student in deductive reasoning. One of the reasons for this may be that it is far easier to present a subject to students by deductive methods rather than by inductive processes. It takes considerably more time and planning on the part of the teacher to present the subject matter by induction.

In this connection, I was impressed with an article by Clarence H. Boeck in the October, 1953 issue of *The Science Teacher* entitled: "Try The *Inductive* Approach." Dr. Boeck describes one of his experiences at using the inductive method in teaching chemistry. I shall not take time here to relate Dr. Boeck's experience but I recommend the article highly to those engaged in teaching science or engineering subjects. We have given much attention to what to teach but I believe we should give more attention to how to teach.

A great deal of intensive training could be given the students in inductive reasoning in the present engineering curricula but this would require drastic changes in the methods of teaching. Furthermore, it might be well to give serious thought to the addition of courses designed specifically to develop the student's ability to think inductively. This might show up some interesting differences in the abilities of students. I am sure that all of you have been amazed at times at the poor showing of a graduate who had very high grades as a student. In some of those cases that have come to my attention, I have wondered if it might not be that the grades gave no reflection whatever of the student's ability to think inductively.

Recommendations

So I would recommend just as intensive training in inductive reasoning as in deductive reasoning to prepare the young engineer for industrial research. However, I would recommend this for all engineering graduates because the primary responsibility of engineering schools is first to train well balanced men and women. Such people will fit into research much

better than the unbalanced, narrowly trained graduates. The engineer of the future must be better informed in such fields as history, economics including business and finance, philosophy, psychology, government and politics. Technical and scientific skills will become merely prerequisites.

It is of great importance that the graduates of our engineering schools be trained broadly and that they be able to think skillfully both inductively and deductively. Also, concentrated effort should be directed toward developing the judgment of the student. He must be made to realize that this quality is undoubtedly the most valuable he can develop. It is far more valuable than brilliance.

The great successes of life do not go necessarily to the most brilliant, nor to the cleverest, or shrewdest, or the best educated. They go to men of soundest judgment. There is no quality so important for the executive as good judgment.

People who have the responsibility for selecting engineers for high positions are afraid of the poorly balanced, narrowly trained men. A man may be smart, sharp, shrewd, clever, a good scholar—even brilliant—but is he sound? Many over-estimate the value of education and brilliance. These are certainly no substitutes for sound judgment—no more so than is knowledge a substitute for wisdom. There is no substitute for soundness of judgment.

Therefore, it is urged that the engineering student not be trained specifically for research. Give him broad intensive training. Develop his sense of proportion. Teach him to think inductively as well as deductively. Give him training in the application and development of his imagination. Allow him the opportunity to develop his ingenuity.

In essence, I hope the engineering schools will turn out well balanced engineers who can practice successfully in any field if their aptitudes are compatible.

College Notes

An evening graduate course for those interested in digital computers and other systems operating with digital information is being given for the first time by **Stevens Institute of Technology.**

A series of evening courses in electrical engineering designed for men in industry who want to bring their knowledge of electronics and circuit theory up-to-date is being given by the **Columbia University** School of Engineering during the Winter Session. The courses are intended for students with B.S. in engineering or science. Completion of the six courses offered will make the students eligible for a graduate program leading to a Master of Science in electrical engineering.

University Extension of the **University of California at Los Angeles** will offer a ten-day engineering and management course from January 23 through February 2, 1956. Six hours of class per day plus luncheon and dinner meetings will cover both traditional and new areas in industrial engineering and management theory and practice.

Dr. G. Wesley Dunlap of General Electric has been appointed visiting professor at **Massachusetts Institute of Technology.** He is on a year's leave of absence from his position as manager of the Instrument and Nuclear Radiation Engineering Services Department.

Value of Research to the Institution*

By G. H. HICKOX

Program Director for Engineering Sciences, National Science Foundation

For the purpose of this paper, it may be assumed first that the institution referred to in the title is an educational institution. Most educational institutions have three principal objectives to fulfill: instruction, research, and public service. These three functions are interrelated, research being of value both to instruction and to public service. It may also have other values internal to the institution. There seems to be no doubt that a little research might improve the utilization of physical facilities and teacher abilities, but these aspects will not be dwelt upon, important as they may be.

A second assumption is that the value of research to an institution is the value that it may have to the institution's objectives of instruction and public service. Consider first the value of research to public service. Probably the commonest and best known application of research to public use is exemplified in the Agricultural Colleges of our Land Grant schools. The Agricultural Experiment Station associated with these colleges are continually at work improving crop yields, soil fertility, animal husbandry, poultry raising, dairy practices, farm economics, harvesting methods, marketing, and many other areas important to American agriculture. Our agricultural researchers have been notably successful in their efforts to improve the situation of the American farmer. They are teaching him better farm practices and are providing him with modern, efficient machinery which will lighten his work load.

Closely related to the work of the Agricultural Experiment stations is the parallel work conducted in Home Economics colleges and disseminated throughout the State by a group of home demonstration agents who work closely with the county agents. The work of these colleges and their representatives in their public service relationships is a striking example of the value of research to the public service function of the Land Grant school.

Another research activity which assumes importance in some areas is provided by colleges or departments of Business Administration. The University of Tennessee, for example, maintains within its College of Business Administration a Bureau of Business Research which is available to business and industry in this State as a public service. The Bureau publishes regular bulletins showing the status of business in Tennessee and discussing currently important matters such as taxation and legislation.

A Third Assumption

Returning from this brief digression, a third assumption may be stated: namely that we are concerned chiefly with instruction; and a final fourth assumption, that we are concerned with instruction of engineers. The value of research to instruction will require a little more discussion than the previous subjects because the results are not so immediately evident although this is not to say that they are none the less real.

Before discussing engineering education in detail, it may be well to stop for a moment and consider just what it is we are talking about. For present purposes,

* Presented at the Southeastern Section Annual Meeting, ASEE, April 14, 1955, University of Tennessee.

engineering may be defined as the *economical application of science and the materials and laws of nature to the satisfaction of human needs and desires.* A recitation of some of the human needs that are satisfied by engineering will illustrate the wide scope within which we operate. Engineering has provided us with our modern transportation by land, sea, and air, our marvelous communication system, our homes, offices, and factories, our enormous power supplies, and even our means of making war.

Need for Scientific Knowledge

And now consider that all of our recent progress has been based on new scientific knowledge, and that further advance must be based on scientific knowledge which is being discovered today or will be discovered in the future. Consider also that we in this country have no monopoly on the production of scientific knowledge or the ability to apply it. We must realize that if America is to maintain its leadership in the world today, we must develop to the full our scientific and technological resources. This requires the training of scientists for the production of new knowledge and of engineers for its intelligent application.

Prior to World War II, much of the basic scientific research was performed in Europe and we were largely importers of new knowledge. The European source was almost completely dried up during the war, and through that period and for some time thereafter, very little new knowledge was forthcoming. We were rapidly approaching the point where the satisfaction of human needs would be handicapped by a scarcity of basic scientific knowledge. It was in part to supply this deficiency that the National Science Foundation was established by the Federal Government for the support of basic research. Many industries and universities have likewise recognized this need and are encouraging basic scientific research. Only with the production of new knowledge will we be able to expand our technology to satisfy our ever increasing needs and desires.

The production of new knowledge alone, however, is not enough. It must find modes of application and these applications require engineers. Traditionally the scientist and the engineer have divergent viewpoints and each from his own vantage point looks down on the other. The engineer, concerned with application, considers the scientist a long-haired recluse who has no idea of practicality. The scientist, engaged in pure research, is as apt to think the engineer a hairy-eared dirt grubber. The divergence of views leads to divergence of action as well with the result that neither understands the other and there remains a wide gap between scientific discovery and its practical application. This gap, that exists between the pure scientist who pursues knowledge for its own sake and the engineer who applies it and adapts it to use, must be filled. It can be filled either by the scientist turned engineer or by the engineer who understands science. We are having difficulty today in training enough scientists to produce the basic knowledge that we need for our later use. It would be extremely unfortunate if the few people who are capable of extending the boundaries of our knowledge were diverted from this pursuit to the application of it in engineering ways. If the scientist departs from his profession to become an engineer, he ceases to be a scientist and this we cannot afford, for we badly need our research scientists to supply the store of knowledge which engineers may later apply. It seems important that we proceed by training the engineer in the understanding of science rather than by making scientists into engineers.

The Educational System

Let us now return to engineering education. We may think of our education as a two-phase system composed of a transmitter, or teacher, and a receiver, or student. Good education depends on the proper functioning of each of these two

phases. As educators, we must stimulate our teachers to the best performance of which they are capable and we must also motivate our students to exercise their will to know. Why are students in classes in our engineering colleges rather than in history, business administration, or mathematics? I like to think that they are in engineering because of the challenge offered to them by the production of new satisfactions for human needs and desires. I like to think that they are here not simply to learn how to do what their fathers and grandfathers have done before them but because they are challenged by a desire to push the frontier of service ever farther.

Since the function of our engineers is to apply the results of scientific learning to the satisfaction of human needs, it follows they must understand the sciences in order to be able to apply them intelligently. To promoting this understanding, our engineering colleges should devote themselves. This means that it will be necessary to teach more of the basic sciences in a scientific way, and we find in fact that engineering education today is in a state of transition from a program with emphasis on technical applications to a program which has much more emphasis on basic theory, on education in the sciences, and on training in research. If we are to teach in our engineering colleges only a knowledge of science and the techniques of its application, we may achieve a technical training, but we are not producing educated engineers. We must be training our students not only how to apply science but also in the understanding of science, and this must be done in the undergraduate curriculum. If the more specialized techniques of application must be taught, then the place for them is in the graduate school of such training may well lead to professional degrees.

Two Wills

We are told that human beings are provided with two wills: the will to know and the will to tell. We possess these in varying degrees but only through their exercise do we preserve, pass on, and add to our cultural and intellectual heritage. These wills should be cultivated. We should stimulate curiosity in our students so that their will to know may be increased and our knowledge thus be expanded. We should encourage them in their means of expression so that the will to tell may be satisfied and the knowledge gained by them may be passed on. To this end we should pay particular attention to the writing of essays and reports. Too often there is lack of cooperation between departments in our schools. The scientific departments pay little attention to grammar and composition, laying any defects in these directions at the door of the Department of English. The English Departments, likewise, are scornful of scientific knowledge. It is the responsibility of all departments to recognize that our culture has an essential unity and that the best interests of our students are not served by operating in an academic vacuum. It is our duty, if we are to maintain our place in the world, to develop our students to the limit of their abilities. Such development may result from contact with teachers who stimulate by example. Most of us can recall certain teachers who influenced us greatly by their mental alertness, by their intellectual curiosity, or by their professional attitude. The effects of the example set by them have undoubtedly lingered long after the details of their courses have faded.

Techniques of Research

The intelligent application of science requires training in the techniques of research. At the graduate level, research and instruction go hand in hand, but what about the undergraduate? What does research do for him? Formal research in an educational institution does a number of things for the undergraduate student even though he does not participate in it directly. First, teaching at the undergraduate level will tend to become dull

and routine and will certainly lag far behind current practice unless the teacher continues to grow and to develop. Such growth and development of teachers can only occur if they are aware of and practice the researcher's way of life. Research is a way of learning; a way of the mind; a continuous satisfying of the curiosity; a continual advance into the unknown. It is the way we have developed and advanced our culture. Students come to an Engineering College because they are challenged by the future. They wish to have a part in discovering it. This motivation should be encouraged and capitalized upon and it can only be done by teachers who are conscious of the challenge offered and who are themselves taking steps to meet it. The interests and the attitudes of our teachers are reflected in the training of our students. The institution with a positive attitude toward research, staffed with a faculty having an interest in and a sympathy for research, will stimulate students to a high level of achievement and creativeness that will not be reached if instruction is confined merely to the passing on of facts.

Atmosphere for Learning

Second, the atmosphere in which the student learns is favorably modified by research in the institution and course content itself is often improved if his teachers are actively engaged in research. New knowledge gained through research is not filed away as data in cabinets or reports on shelves. The new facts uncovered become a part of the curriculum and thus a direct and immediate benefit to the student. Teachers who have been engaged in classified, contract research—and this is not basic research, but application, not directly related to undergraduate instruction—have found that the work they have been doing in the application of science to the fulfillment of their contract obligations has made them better able to understand their own special fields. This is quite understandable because the application of science requires a knowledge of it and successful application requires an understanding of it. These teachers have found that the increased understanding of their own fields required by the application to special needs has enabled them to teach the basic science to their students with fuller meaning. This is one of the advantages of research—even of classified contract research—which is not generally recognized. It is, however, none the less real. As a matter of fact, it may even be true that research of this type is reflected in undergraduate instruction fully as quickly as research into the borders of knowledge which the undergraduate may not be fully prepared to understand.

Third, an institution which has underway a program of research finds many opportunities to utilize the services of undergraduate students for participation in the work. Such actual participation serves to stimulate the interest of the students, to maintain their motivation, and to train them in the techniques of research which should be a part of the educational process. These are some of the immediate and direct benefits of a formal research program.

Important Concept

Above and beyond these direct benefits, however, is a broader and more important concept. Research is the indispensable attribute of the engineer who will advance his profession or even keep up with it. In this sense all engineers must conduct research if they are to realize the potentialities of their chosen profession or to make their dreams come true.

Finally, and not least, is the concept of research as a way of life, an attitude of mind, a fulfillment of the human wills to know and to tell, the preservation, the extension, and the transmission of our cultural heritage. This is the way in which the university can fulfill its obligation to society.

The Value of Research to Graduate Instruction*

By WILLIAM G. POLLARD

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At first sight the title of this paper seems almost trite. What can be said apart from the repetition of time-worn platitudes on such a subject? Is it not true that research lies at the very heart of the graduate program? What would a Ph.D. or even a master's degree be without a dissertation or thesis involving independent research? Is a graduate program thinkable without a strong central emphasis on the value of research in it? Such questions as these make the whole subject appear to be clear cut and simple. Yet apart from the traditional and theoretical values of research in graduate education, there are practical and empirical aspects which make the subject appear much less simple and clear cut.

To begin with there is the largely post-war phenomenon of industrial research institutes associated with universities and of the multitudinous government research contracts which have sprouted and multiplied in the science and engineering departments of our universities. In many cases these activities have come to command so much of the enthusiasm, interest, and energy of the faculty that teaching, even at the level of graduate instruction, seems to have become a secondary, even peripheral concern of the department. All too often a professor reluctantly and grudgingly interrupts his project research to meet a classroom schedule which he has come to regard as a necessary evil. The associate lack of enthusiasm for the educational enterprise as such is communicated to the students, and the result is not only a sharply decreased effectiveness of instruction, but often a loss of students to other fields. This whole situation may well be one of the major contributing causes for declining enrollments in science and engineering about which there is currently so much justified alarm.

Secondly, there is always the tendency, particularly in departments with large numbers of graduate students, for thesis research to approach mere hack work. Under the pressure for finding a considerable number of thesis assignments which are fairly sure-fire, unimaginative and often trivial problems are selected in which research is reduced to apparatus construction and data taking. Although such assignments do have some value for training in techniques, data analysis, and report writing, it is not surprising that the ever-growing pressure for more courses, which every curriculum experiences, leads in such cases to serious questioning of the value of research in graduate instruction. From the standpoint of the students, such research comes frequently to be regarded as simply one of the most heavily time-consuming and onerous of the obstacles placed between them and their degrees by an arbitrary administration.

Finally, there is the very serious problem in every technical field today of the enormous increase of the volume of knowledge required for competence in the field. Just a few decades ago the core of a graduate education in physics involved only classical mechanics, electromagnetic theory, and possibly relativity theory. Today all of this is still basic but there

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has been added to it as equally basic quantum mechanics, and now quantum field theory. For graduate work in chemistry there has been added to the whole structure of classical chemistry, the quantum theory of valence, atomic structure, and spectroscopy. The engineering fields are currently struggling with the evident necessity for basic training in nuclear physics and radiation on top of already too crowded curricula. More and more the question is being seriously raised as to whether the traditional dominant role of the research problem and thesis in graduate education can be justified in competition with such cogent and compelling subject matter demands.

It may perhaps be sufficiently clear from these considerations that our topic is by no means so simple and clear cut as it may at first have appeared to be. There are practical, if not theoretical, difficulties of a very real and certainly most stubborn character in contemporary graduate education in science and technology, which raise questions about the traditional values assigned to research. I wish it were possible for me to say something significant to you today by way of suggesting feasible paths out of these difficulties. Unfortunately I have neither the wisdom, nor any longer the immediate experience of day-to-day grappling with them, to attempt such a task. The more I hear discussions of these problems by those engaged directly in graduate education, the more I realize how exceedingly stubborn and complex they are, and the less am I inclined to launch brashly into the blueprinting of a solution.

Subtle Aspect

There is, however, one rather subtle aspect of this whole problem which seems to me both fundamental and crucial. This is what I like to think of as the "community" character of both scientific and technological professions. Here I have in mind that aspect of graduate education which is directed toward the full incorporation of the students into a professional community, as opposed to such other aspects as course content, mastery of facts and methods, or the development of facility in techniques and equipment. It is from this standpoint, it seems to me, that the value of research in graduate education can be most fruitfully discussed.

Those who are involved in the process of graduate education tend to become more and more preoccupied with the machinery. This is natural and indeed to a certain extent inevitable. When improvements are to be made in the process, one naturally looks for specific steps which can be taken. But such steps always consist of modifications in existing courses, new courses, new laboratory experiments, special student projects, and the like. But important as all of these formal aspects of the graduate program unquestionably are, they nevertheless do not touch the real heart of the problem.

The difficulty is that the heart of the matter is so subtle. For basically what we are trying to do in graduate education is to turn out competent members of our own professions. That is we are not so much trying to teach physics or chemistry or engineering, as we are trying to develop physicists, chemists, and engineers. These two objectives are, however, quite distinct from each other. Physics and chemistry overlap extensively in content and subject matter; so much so indeed that it has become essentially impossible to frame adequate definitions for either of them in terms of bounded subject matter provinces. There is, however, no difficulty when it comes to telling a physicist from a chemist. They are quite clearly members of two different communities of inquiry with different ways of approaching the same problem and different criteria for determining what is significant and important. Indeed there have been those who, despairing of the possibility of finding an adequate definition of physics in terms of classes of phenomena, subject matter categories, or methodology, have sug-

gested defining the subject as consisting simply of everything done by physicists.

Such a definition of physics, chemistry, electrical engineering or any other scientific or technical field is not as trivial or tautological as it may at first sight appear. For each of these subjects has come into existence historically because of the formation of a dedicated community of men sharing a common approach to the investigation of nature. None of these communities of inquiry could foresee what areas of nature this approach would ultimately lead them into, or what content their subject would acquire as a result of their investigations. The plain fact of the matter is that the content of chemistry today is what it is, not because of any inherent segregation of natural phenomena along the lines delineated by the contents of a modern textbook of chemistry, but purely and simply because that particular body of information represents the aggregate fruit of the labors of chemists over the years. Each of our subject matter fields exists because of the creative activity of a community of investigators with a common bond between them. Every such community has tremendous creative power of itself. Its members learn from each other and teach each other. Only within the community can the achievements of each member be fully appreciated and only within the community can the rigid critical discipline necessary for real achievement be applied to each member in a spirit in which it is gladly accepted.

If we look upon our several scientific and technical fields in this light, then I think you will all agree that the really basic objective of graduate education is not primarily the acquisition by the student of a certain predetermined level of technical information and professional competence, but rather his full incorporation into the professional community. The basic objective of a faculty of chemical engineering is to turn out men who both feel themselves to be chemical engineers and are accepted as such by the profession at large. Certainly the achievement of this objective depends in a critical way on an adequate mastery of a body of subject matter, knowledge of and facility in both intellectual and manual techniques, a balanced sensitivity to technical and economic limitations and possibilities, and many similar competences. But although all of this is essential, it does not of itself add up to a real chemical engineer. There is a clear overplus required which I think we all recognize, but which is very difficult to define or pin down.

Confrontation with the Unknown Tests a Man

It is just here that the importance of research enters the picture. For it is in the carrying out of significant research more than in any other activity that the subtleties we have been describing are transmitted from professor to students. In any professional field it is the confrontation with the unknown that really tests a man. That which really makes a scientist or an engineer what he is reveals itself when he comes up against an important problem whose outcome is unknown and whose solution is not obvious. In such a situation all the undefined bases of confidence, the sureness of approach, the characteristic ways of going about things, and the peculiar disciplines that make a physicist or a chemical engineer what he is show themselves. The student, confronted with the unknown in this manner in his own research, derives more than he will ever thereafter be able to explain from the experience of having his major professor join with him at critical phases of his investigation. In such situations the full implications of the nature of the profession are directly experienced by professor and student together. This, however, is the only manner in which they can be acquired, for there is no way in which they can either be taught or learned.

From this standpoint we can see why artificial problems or hack-work research

will not do. It is only in real, living situations that these qualities emerge. It is necessary that the problem be considered significant and important by both the professor and the student, as well as by the professional community at large. It is also necessary that the problem really challenge the professor as well as the student. Mere data taking, report writing, or routine or made-up problem solving are powerless to evoke these values. The adventure of research with all its alternations of joy and despair, of excitement and drudgery, must really be present and fully shared by professor and student together if the objective is to be obtained.

During the last several years I have been involved on several occasions in discussions of the problem of what the engineering schools should be doing about the new field of nuclear engineering. I feel sure that all of you in this Society have wrestled with this problem extensively yourselves. For my part the aspect of it which has emerged increasingly clearly in my own thinking is the effect which the absence of a sense of professional community has upon this problem. Most universities have been able to introduce quite adequate new courses and additions to existing courses into their curricula to meet the needs of engineers planning to go into nuclear work. By now there are also reasonably adequate texts and reference materials available for such courses. Short of an operating nuclear reactor, it is even possible to provide essentially all of the necessary laboratory work for instruction in this field. But in spite of the adequacy of such instruction, it does not result either in attracting students to the field of nuclear engineering or of producing men who are distinctively nuclear engineers. One of the committees which the Oak Ridge Institute of Nuclear Studies called together two years ago to study this problem expressed the matter this way:

> The most important problem is that there does not exist within the universities a nuclear energy tradition adequate to meet the demands which will be made of nuclear engineering education at the highest level. This inadequacy comes primarily from the fact that almost all the highly competent or authoritatively informed people in the field are still in the industrial or government areas; few have so far found their way into the educational framework.

Crucial Element

At the heart of all professional education, particularly at the graduate level, lies this recognition of the existence of a living community of persons with a special professional competence. Within the university where the community enlarges and extends itself, the process by which it does so is not so much one of teaching and instruction as it is one of contagion and reproduction. This it seems to me becomes very clear in an entirely new field such as nuclear engineering where one can see the effect of providing only teaching and instruction in the absence of persons who consciously and recognizably represent the new professional community as the primary center of their professional life and challenge.

Once this idea is recognized as a crucial element in the whole educational process, it seems to me that the role of research in graduate education becomes evident. From this vantage point, research can no longer be considered merely as a teaching device for the learning of specialized techniques, the development of habits of precision, or the encouragement of independence. One comes instead to see graduate student research in the light of the occasion it provides for the sharing of a unique kind of experience by professor and student together in a manner which is peculiarly reserved to their special profession. Since such occasions play such an indispensable role in the process by which our several professional communities extend and reproduce themselves, it is difficult to see how we can really make a student one of us without making his research project a central feature of this graduate education.

The Fight for Ethics in Engineering *

By JOHN R. SNELL

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A young man who clerked after school asked his father one day to explain to him the meaning of ethics in the field of business. His father replied, "If a customer should unknowingly pay me $10 too much, ethics is whether or not I tell my partner."

I consider it an honor and a challenge to outline something of the fight going on to raise the ethical standards in the Engineering Profession. I hope to enlist your enthusiastic support in this battle. Our greatest opposition is still a lethargy on the part of the engineers themselves. This is largely a problem of education and one for which we should feel compelled to accept full responsibility.

Discussion might best be confined to the following three questions:

1. How serious a problem is Ethics for the Engineering Profession?
2. What are and what should the engineering societies do about the problem?
3. What are and what should the educators do about the problem?

There are others far more capable of discussing these important subjects but probably none would be as frankly outspoken about the problem. My suggestion to each of you is that you take the responsibility upon yourself to read all the articles written on engineering ethics in the last two or three years and do some independent research and hard thinking on the subject. This study may help you get a burning conviction of the bigness of the job to be done and help you feel your part in accomplishing it.

* Presented at the Annual Meeting of ASEE, Civil Engineering Division, Penn State University, June 23, 1955.

Serious Problem

First: How serious a problem is ethics in the Engineering Profession? It is far more serious than most engineers realize or would be willing to admit. Four important basic ethical problems face the profession. The first two show lack of integrity or actual dishonest practice; the last two involve the ignoring of accepted ethical standards of the profession. They may be stated as follows (1):

1. Giving "kickbacks," "commissions," "finder fees," "payment for influence" to assist in obtaining engineering work;
2. Accepting commissions or engineering aid directly or indirectly from contractors, equipment manufacturers or other parties;
3. Reducing fees below minimum accepted standards or competing on the basis of price;
4. Undercutting the professional reputation of another engineer or attempting to supplant an engineer where steps have been taken to employ him.

The vicious malpractice of giving kickbacks or accepting commissions from manufacturers and others was widespread four years ago in many of the larger cities on the Eastern seaboard and the midwest, and I understand is little improved today. The malpractice of reduction of fees is to some degree present almost everywhere. This, of course, leads to poor engineering, uneconomical designs and a low professional standing. The malpractice of "bidding" has received some attention and publicity in the past year yet it still continues (2) (3). Undercutting and supplanting fellow engi-

neers is privately admitted in even some of the most respected engineering firms when competition gets tough.

Everyone gives lip service to ethics but what actually takes place is something else again. This was evidenced also in October, 1954, in an open meeting held in Cincinnati by the Ethics and Practices Committee of the Engineering Council for Professional Development (5).

Four years ago a story of my own experience with malpractice in the profession was turned down by a half-dozen national engineering magazines because in their editors' minds it was too hot an issue for publication. The JOURNAL OF ENGINEERING EDUCATION published it in uncensored form in May, 1953 (5). The response to the printed article by the engineering educators was encouraging. One insisted it should not remain buried in the JOURNAL, and 400 reprints were sent to the state and national offices of various engineering, architectural and contractors organizations.

These stirred up interest where it was needed and over 1500 additional reprints were ordered. A supply of the reprint is available for the asking.

How will the continuation of these malpractices affect the Engineering Profession? The respect and high professional esteem given us by the public is already being severely shaken in some areas and may be undermined completely if it long continues. High ethical standards are a firm prerequisite to any profession, especially the engineering profession (6). The public will not stand for an egg that is nearly fresh, a boat that floats most of the time, or a parachute that almost opens.

Second: What are and what should the engineering societies do about the problem? Perhaps we can better understand the problem if we first compare ourselves with our friends in the medical and legal professions. The doctors through their American Medical Association and the lawyers through their American Bar Association may severely reprimand one of their members, or if the malpractice is serious enough, may take steps to have him disqualified from practice (7) (8) (9). Doctors and lawyers alike have been very active in controlling any violations of ethics in their professions. Especially has this been true on the west coast where their problems have been serious.

The engineers, in contrast, have over eighty different societies. Despite the fact that a standard Canon of Ethics was adopted by a majority of the societies in 1947, it has had little or no effect in improving the situation. The greatest punishment which one of these engineering societies can administer for malpractice is expulsion from that particular society 1947, it had little or no effect in improving the situation. The greatest punishment which one of these engineering societies can administer for malpractice is expulsion from that particular society and even here unethical engineers are partially protected by the ethical obligation of all engineers to refrain from "harming" another member of the profession. Also, most cases of unethical practice in engineering are difficult, if not impossible, to prove; so why bother to prefer charges when the chances of proving them are slight? In the last analysis, expulsion from an engineering society in no way affects the engineer's right to practice. Unethical men are often callous to this almost meaningless type of reprimand and become all the more determined to continue their profitable malpractice.

No Central Watchdog Agency

Despite this serious handicap for the engineering profession, of no central watchdog agency such as is available to the doctors and the lawyers, some small progress is being made to improve ethical standards. The twenty or more articles in our technical journals on ethics in the last two years are evidence that serious thinking is going on. Ethics and practice committees of many of the major

engineering societies have been reactivated and are again beginning to study the problems confronting them for fresh answers. Increased reprimands by the ASCE and NSPE this past year for bidding (3) (10) is a good indication that the societies mean business.

As a member of the Ethics and Practice Committee for the Michigan Society of Professional Engineers, I have seen some serious study given to the state and national problems. For example, a suggested program on ethics and practice has been prepared for national usage to educate the following ten areas on ethical standards and practices of engineers:

1) Municipal officials
2) Equipment manufacturers
3) Industrial management
4) Engineering professors and students
5) Telephone companies
6) Organized labor
7) Engineers
8) Architects
9) Surveyors
10) Contractors

Each area has different problems and a continued educational program is recommended through the discussion of these problems by qualified men in appropriate periodicals.

Other programs under way include proper classified telephone listings of professional engineers, employment of only registered men in responsible public engineering positions, investigation of such unethical practices as are reported to have occurred, and elimination of competitive bidding for professional services.

A most important and difficult task yet lies ahead. So far the problem has been generally avoided despite the fact that in its solution lies the key to any major upgrading of ethical practice in the engineering profession. Basically it is a problem of setting up a single workable mechanism for the profession to effectively deal with unethical engineers, just as doctors and lawyers are able to reprimand unethical members of their professions. Our present systems vary from society to society but all have the common fault of being unworkable and ineffective. The control of unscrupulous men in the engineering profession by present methods is about as effective as the Girl Scouts controlling crime in Chicago. Several of the major engineering societies should take responsibility to formulate a workable effective plan and sell it to the other societies. This cannot wait 10 or 20 years to happen without endangering the professional standing and reputation of engineering in general. This conviction is a growing one, as is indicated by Mr. H. A. Wagner, consulting engineer and chairman of the State Boards of Examiners (7). The newly formed Board of Ethical Review (11) of the National Society of Professional Engineers may be a first step in the right direction, but let us not rest until the job is done completely and effectively and we have a watchdog which is a watchdog.

An interesting report on engineering ethics in England and on the continent by Fritz D. Hirschfeld (12) indicates that ethics are taken much more seriously there than in this country. In Sweden, for example, a promissory note for $2600 is held by their engineering associations as a guarantee against malpractice.

Growing Problem

Another serious and growing problem should be mentioned before passing on to the third and final phase of this discussion on ethics. The unions have made alarming inroads on the lower pay brackets of our "engineers-in-training" and, in fact, on our professional engineers themselves. This problem has been ably discussed by both Dean Dougherty, Dean Freund and others (13) (14). Essentially the problem is higher wages and recognition of professional status of these men by their employers. Both industrial management and the young engineer alike need to be educated for the best solution

of this problem. For some consulting firms the problem may have roots in "fee cutting." In any event no one really wants the unions running any part of the engineering profession.

Third: What are and what should the educators do about the problem? We in engineering education are concerned as to what we are doing and what we should be doing to improve ethical standards and practice in the profession. The reports given by Dean C. J. Freund, Chairman of our Society's Ethics and Practice committee are revealing (15) (16). Indications are that many educational institutions are doing virtually nothing to give their engineering students an understanding of ethics in their profession and the vast majority of schools are doing far too little. Only a handful of the institutions appear to be doing a first class job. The problem appears to be two-fold:

1) Our crowded engineering curriculum makes us feel that time cannot be spared for a formal course in ethics.

2) No suitable text or collection of material is available and also many educators feel that ethics cannot be effectively taught in a formal course.

To a degree all this is true, yet we cannot overlook a serious problem because of a lack of time or a lack of tools. Materials presently being solicited by the Ethics and Practices Committee of the ASEE may well form the basis of an effective course (16). The January, 1955 issue of the *Annals of The American Academy of Political and Social Science* (7) would be a very valuable reference for students and teachers alike. Time can always be gained from some other area—either technical or non-technical. There is no use making a good technical engineer if he can't be honest! Further conviction on the need for teaching ethics and some helpful suggestions are given by both M. D. Cooper (17) and N. W. Dougherty (18) in recent articles. Mr. Cooper suggests that if a full course cannot be given on ethics a substantial part of a general course on Engineering Practice should be devoted to the subject or perhaps a series of seminars should be held.

Tau Beta Pi should be congratulated for its two recent forward steps to promote high ethical standards (19). First, every electee was encouraged in 1955 to write an essay before his initiation on some topic concerning engineering ethics. Second, distribution of a brochure on ethics is made to each electee.

Students should be encouraged to read and to think independently in the field of ethics. Writing for the Daniel W. Mead essay contest with $50.00 and $100.00 prizes should be encouraged (20). Student society meetings, both technical and honorary, provide an excellent chance for growth in these moral standards. Special lectures and speakers on ethics can help to mold students' minds and formulate their standards of personal and professional conduct.

Honor System Valuable Tool

My own experience indicates that the student honor system is a very valuable tool in teaching moral values and building character in young men. Every engineering school should aim for a student-run honor system and their staff should each take a personal responsibility to know the students well enough to make certain that it is functioning one-hundred percent (21).

One final point and probably the most important one. Engineering ethics cannot be taught in the same sense that math or structures are taught. A student's grade of "A" in his Ethics class gives no assurance of his honesty, fair play or moral guide posts he has chosen to govern his way of life. These qualities have been fairly well formulated into what we call the student's character long before we as college teachers come in contact with him. The greatest influences on these students' characters are their homes, friends, schools and churches. Some influences may have

been uplifting, some degrading. What the engineering faculty says and does both in and out of the classroom have a very important part in the building of character of our young engineers. The building of a high moral climate is every teacher's job. Let us remember that the roots of all sound ethical standards are moral and spiritual.

Probably the most scientific and outstanding experiment and experience comes to us in the Kentucky Program of Moral and Spiritual Values in Education launched in 1946 (22) (23). This has been a unique cooperative program of the Kentucky State Department of Education with nine colleges and universities and two foundations. Remarkable success has been reported in teaching students moral and spiritual values not through special classes on such subjects, but through a carefully planned program of bringing out and emphasizing these values both in the existing formal curriculum and in extra-curricular activities. The success of the Kentucky program in these few years appears to many thoughtful educators as a turning point in education. It certainly would have an important bearing on the world ideological fight for men's minds! It can be our best and only certain way of integrating integrity with engineering technology. Finally, technology without integrity is like a ship without a rudder. If we are to continue to build ships, let us do the whole job and build the rudders as well.

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Midwinter Meeting of the Engineering Drawing Division

The Midwinter Meeting of the Engineering Drawing Division will be held from Thursday, January 26, through Saturday, January 28, at the Illinois Institute of Technology, Chicago. Registration will be conducted Thursday afternoon and Friday morning.

The General Session Friday morning will feature papers on *Technical Drawing for Science Majors* by E. G. Paré, *Design Consideration in Engineering Drawing* by H. C. Messinides, and *Relation Between Engineering Drawing and Machine Design* by L. M. Sahag.

Papers featured at the General Session Saturday morning will be *Should Colleges Teach Drafting Techniques?* by J. Gerardi, *Simplified Drafting* by J. H. Bergen, and *Introductory Nomography* by A. S. Levens.

Other activities will include a luncheon, luncheon and business meeting, banquet and miniature opera presentation, Open House at IIT's Technical Drawing Department, tour of the *Chicago Tribune* plant, and optional field trips to Chicago landmarks.

Enrollment and Incomes in Civil Engineering can be Increased*

By HARRY RUBEY

Chairman, Department of Civil Engineering, University of Missouri

Civil engineering has dropped to third place in enrollment and incomes. What can we educators do about it?

This paper attempts to look forward from fifty years of experience and to resolve the paradox of enrollment and income falling relatively while more graduates at higher incomes are needed for the technical and management staffs of American industry, especially for its largest industry, construction. The paper iterates briefly and brings up to date a paper and bibliography on a similar topic presented a year ago and published in condensed form in the *Civil Engineering Bulletin* of ASEE for March 1955. It should be useful in applying the findings of the ASEE Committee on Evaluation.

The Crisis

We, at the height, are ready to decline.
There is a tide in the affairs of men,
Which, taken at the flood, leads on to fortune;
Omitted, all the voyage of their life
Is bound in shallows and in miseries.
On such a full sea are we now afloat,
And we must take the current when it serves
Or lose our ventures.

From Shakespeare's *Julius Caesar*

A critical shortage of engineers threatens national welfare. Secretary of the Air Force Quarles has recently written that this shortage of engineering and science graduates is a major peril to the United States, in contrast to the much greater number educated in these fields in Russia. Lt. Gen. Groves (retired), atomic expert, questions "How long can we expect to survive if our present annual production of engineers is only 20,000 and not increasing, while Russia's is 54,000 and constantly increasing?" We must note further that Russia also greatly surpasses us in training sub-professionals and in emphasizing mathematics and science at both higher and lower levels. Both Churchill and Eisenhower indicate that our present technical superiority may be short-lived.

As an example of great importance to civil engineering, the national Associated General Contractors of America, the national Highway Research Board, and many others warn that a shortage of civil engineers threatens construction and this in turn menaces all industry and national defense.

Construction and Education Are Essential for Full Employment

Most business commentators credit construction as a bulwark of present prosperity. Furthermore, prosperity for the future is even more dependent on construction and education. Construction will provide immediate jobs, and education will keep part of the labor surplus in school. For the more distant future, they together will provide the research, plant, equipment and personnel housing, automation, technical and management personnel, know-how, and jobs needed to absorb the two million new workers that

* Presented at the Annual Meeting of ASEE, Civil Engineering Division, Penn State University, June 23, 1955.

will be added each year to our present working force of sixty-five million persons. Construction needs more civil engineers; then it will provide more new industrial facilities that will employ more workers. Consumer and war spending does not create new plants although it does create a demand for them.

This constantly increasing supply of jobs is essential for increased living standards, for strengthened national defense, for winning political elections, and for the very life of a successful democracy. We are committed to it politically. No party can win an election without full employment. The alternative to a large construction program is a change of political administrations, unbalanced budgets, increased debt, inflation, and the ruinous effects of unsound money especially on white collar, old age, and low income groups. Construction can be largely self-liquidating and will support much education, both directly and indirectly.

Construction

For several years expenditure for construction, replacement, and maintenance of our industrial and governmental plants has exceeded $50 billion annually, thus becoming America's largest industry. The 1954 expenditures of $52 billion are increasing to over $56 billion in 1955 and should continue at rising levels. The overall construction program will comprise 15% of the total national production and will employ nearly 10 million workers. The highway program alone may spend $100 billion over the next 10 years.

Investigation by the national Associated General Contractors has indicated that adequate material, labor, and equipment will be forthcoming, but that the bottleneck in construction is the increasing shortage of construction engineers. The national Highway Research Board estimates that most of a year's entire U. S. output of civil engineering graduates may be needed soon for highways alone, instead of the few per cent annually entering that field.

High School Preparation

So that their students may be prepared for engineering, high schools must emphasize mathematics and science, especially mathematics, since such studies in high schools have dropped to an all-time low. Of a recent rural high school group of 250 boys and girls, a very satisfactory 36 per cent, all men, were interested in engineering, but only 5 per cent had the required 3 units of mathematics, 7 per cent had 2 units, and the balance 1 unit or less. This fatal obstacle must be overcome. More high school graduates of both sexes must be attracted to the large and well-paid fields of construction and management.

Civil Engineering Education

The engineering colleges must double their output of civil engineering graduates, of whom about a third enter the armed forces and another third accept minor management positions. Corresponding attention must be given to graduate study and research in the construction field. Such an educational program will be designed to give better, quicker, and less expensive construction; to reverse the increasing construction costs that now are a burden on every business and every individual; and to facilitate national defense.

There now exists the greatest potential demand ever known for civil engineers. Civil engineering technology is neither new nor spectacular, is not advancing as rapidly as that of other engineering, and cannot compete on these bases. Its lack of appeal to young men and women must be corrected. Considering all departments of engineering, civil now suffers slightly lower median incomes, due largely to low governmental salaries. By fortunate contrast, contracting and professional management pay the highest. Remedial action is mandatory. How little is, or can be, done by engineering societies toward increased incomes is explained in an editorial in *Engineering News-Record* for March 17, 1955.

Construction and "Professional" Management

How can we regain our lost prestige? Minor alleviation will not revive a declining phase of education, as witness the dead languages. We must maintain our proved and established disciplines but realize today's need for engineered construction and for professional management, then realistically prepare more students to meet modern critical industrial and defense demands while assuring increased incomes for them. The actual curricular change needed is slight and is far within the 10 per cent allowed by the ASEE Committee on Evaluation. Massachusetts Institute of Technology already has a major option in Construction and Management. We at the University of Missouri now use only six credits or four per cent of the curriculum for Construction and Professional Management, and other engineering colleges have similar programs. It is not advocated that descriptive details of construction and management be taught in college nor is it contended that the four-year graduate entering construction and management is fully educated. He, like the researcher or designer, must continue to learn although he will undertake graduate study less often.

However, as anything we want students to consider seriously, the importance of construction and professional management must be impressed upon them in many ways, although not glamourized. For example, they should know that already the 1950 census classifies half of professional civil engineers in construction, that management is now a profession requiring an educated professional viewpoint which is easily included in engineering curricula, that getting along with people is essential for both construction and management, and that even the technical engineer must know and conform to the aims of construction and management. Construction and management situations should be emphasized more in most of our courses. In line with modern trends and developments, we should publicize such terms as *engineer-contractor, engineered construction, construction management,* and *professional management.*

Construction (including suppliers of materials, equipment, and the like) provides mainly management openings. In addition, there are excellent positions for our men in the professional management of government such as in city managership and in highways; and in industry other than construction such as the railway, aircraft, oil, steel, chemical, and public utility fields. Fortunately, the civil engineer who is qualified in construction management can either remain in construction profitably or change over to upper level industrial management.

Because of obsolescence, new products, bombing hazards, decentralization, and the like, the construction and expansion program today is often as important to an organization as its operations. Thus former engineer-managers of construction now are becoming even more necessary and valuable as top professional managers for industry than in the past, and this has always been the civil engineer's main approach to top management.

Many of our graduates will find satisfying careers intermediately between management and technology as staff officers, consulting engineers, marketing specialists, financial advisers, managers for associations, and the like.

The Rise and Fall of Engineers as Managers

Around the turn of the century, managers were strong entrepreneurs and lucky gamblers (rarely engineers) who built their own businesses, and often lost them. The few larger corporations were often in receiverships.

Then followed a period of larger corporations managed mainly by lawyers, marketing men, financiers, and engineers who seldom had sought management positions; more often they were impressed into management. Failures still predominated the scene.

Since the great depression the need has become recognized for professional managers (most frequently engineers), not those rugged individualists of the early period nor the capable specialists of the middle period, but men trained from the beginning to become conservative professional managers (almost trustees) for unbelievably large and stable organizations where failure must be prevented. They are skilled in government, tax law, mergers, finance, public relations, and human relations; with their eye on management at intermediate and high levels, including board policy determination and above management details such as are usually taught in colleges. This group must start early, for example in college, to partly direct their attention toward professional management rather than exclusively toward technical specialization and science.

Civil engineers can better be pointed in this direction while in college than can other kinds of engineers who are becoming increasingly swamped under specializations in science, technology, and gadgets. Art, rather than science, characterizes both civil engineering and management. Even before this trend toward science the larger corporations favored civil engineers as managers. For example, half of the presidents of our larger railroads were civil engineers, while no other engineers occupied presidencies even though there were nearly as many of them on railroads as there were of civil engineers. And civil engineer executives predominated in the growing steel, oil, and other large industries. Consulting engineer-management firms frequently were staffed with a considerable proportion of civil engineers.

In November, 1952, a study in *Fortune* magazine showed nearly 45% of America's top industrial management to have engineering backgrounds. But it also showed that this percentage was greatly decreased (to 28%) for those under 50 years of age; in other words, that the proportion of engineers in top management had passed the peak and that younger engineers already were losing out to non-engineers (often to graduates in business administration) who more aggressively prepared and sold themselves for management.

Now civil engineers are losing their hardwon leadership and new examples of missing their management opportunities occur constantly. For almost the first time in history, a baggage master instead of a civil engineer has been made president of the Pennsylvania Railroad; a board chairman and civil engineer of Standard Oil of New Jersey was succeeded by a geologist; civil engineer president of A. T. & T. was succeeded by an electrical engineer; a cost-accountant has become board chairman of Ford Motors although in the past civil engineers like the late L. F. Loree, not accountants, mounted to top management through cost controls; a lawyer-financier has succeeded a civil engineer as board chairman of U. S. Steel; and a civil engineer president of the great Canadian Pacific Railway has been succeeded by a mechanical engineer with some interest in management.

There are those who will say that we should train good engineers and some will become managers, but nowadays the odds are against them and the possibility in this direction is rapidly diminishing. Civil engineers in the past were drafted into management, sometimes unwillingly, and they seldom prepared for or sought it. But conditions have changed. If we educators do not point out this management opportunity and give introductory study leading to management, our few graduates will largely remain technicians or modestly paid professional engineers and they will not be given management responsibilities and training by their employers.

Fortunately civil engineers now are needed to manage construction and can rise again in management by stressing education for construction and professional management. By the same process, some will develop the art of "how to be happy, though managed."

A Program

The present low ebb in civil engineering education has been developing over the years and will not remedy itself without strenuous effort on our part. Let us retain our established and proven disciplines but point them a little more toward construction and professional management, leaving additional basic science and specialization for graduate study. The holder of a bachelor's degree only seldom will become an outstanding professional designer, researcher, or educator and he should not be misled into thinking that he will.

As our management-trained civils take over more management positions that were being filled by others, those civil engineers remaining in design, development, research, and teaching will enroll for more graduate study, will become truly professional, and will be better paid. Our enrollment and prestige will increase; our graduates will think better of us; and from influential management positions they will more actively support us and our departments financially, by sending us students and employing them, and in other ways.

The national Associated General Contractors last summer established an Educational Committee that is prepared to increase actively its present cooperation with us. Chairman D. W. Winkelman of that Committee, also member of the American Society of Civil Engineers and president of the D. W. Winkelman Company which has just completed part of the Ohio turnpike, is author of an important article entitled "Construction Management Needs the Civil Engineer" in *Civil Engineering* for February 1955 in which he states, ". . . My purpose here is to stress what I believe is the equal necessity for thoroughly competent men to engage in the management of construction firms which actually build those facilities that are vital to the progress of the country. . . . Management needs the civil engineer with construction experience and managerial and executive ability."

Conclusion

In conclusion may I plead that civil engineering educators collaborate in a comprehensive and inter-related five-fold campaign before it is too late, including:

1. More mathematics in high schools, starting in junior high and involving close cooperation with high schools.
2. More effective solicitation of high school students, assisted by the Associated General Contractors, highway departments, and industry.
3. At least one course at the senior-graduate level in *Construction* (management, not construction details) and one course in *The Engineer's Relation to Professional Management* (principles, not details), perhaps including introductions to law and engineering economy.
4. Emphasis on these areas in our classes and public relations.
5. Sufficient research, graduate study, and public relations to assure getting our share of the college student body.

For the want of a nail the shoe was lost,
For the want a of shoe the horse was lost,
For the want of a horse the rider was lost,
For the want of a rider the battle was lost,
For the want of a battle the kingdom was lost,
And all for want of a horseshoe-nail.

From Benjamin Franklin's *Poor Richard*

For the want of a realistic shift in emphasis, shall civil engineering accept a permanent third place in engineering? All five points of the campaign must be adopted together; they will not be effective separately.

Designing the Educational Program*

By G. A. HAWKINS
Dean of Engineering, Purdue University

During the past several years considerable confusion and many differences in opinion have resulted from discussions dealing with the remodeling of mechanical engineering curricula. The problem is complicated by those who are advocating more solid state or modern physics, more industrial management, and more of this and that. As a result some of us are redesigning programs of study simply by reshuffling courses, adding one or two and removing others in a manner which is not based on sound engineering analysis and synthesis.

My plea is to design the educational program in the same way that we would design any complex engineering system. First let us define the problem, establish the fundamental elements, design the program, and develop courses to accomplish the objectives.

In order to present my thoughts, I wish to define engineering in the following manner:

> Engineering encompasses the application of various principles and concepts of the physical and life sciences and background knowledge (the basis of the art of engineering) to the study, creation, and design of systems composed of structures, energy converters, circuits, processes, or combinations of these elements; and the analysis, synthesis, and prediction of their behavior under specified working conditions in terms of men, materials, cost, and time.

* Presented at the Mechanical Engineering Division Dinner, Annual Meeting of ASEE, University of Illinois, June 16, 1954.

I. *Characteristics of Professional Engineering*

Having established this concept of engineering, it seems desirable to consider briefly the characteristics of professional engineering. For this discussion, I would like to utilize information furnished me during personal conferences with Dean A. A. Potter, Dean L. M. K. Boelter, Dean C. S. Hollister, and many practicing engineers. A composite opinion indicates that some of the characteristic requirements and situations which confront professional engineers are:

1. Professional engineers are assigned specific tasks during the course of their work. This is not always the case with the scientists, for they are often free to select the problems which most interest them.

2. Professional engineers are always required to meet deadlines. They must reach a decision during a specified time interval. In general, time does not play so vital a part in the work of the scientist.

3. Professional engineers are almost always obliged to work closely with other people who have not been trained as engineers. Due to the complex nature of their problems and the many social factors involved, engineers often work as members of a team. For example, the design of a dam requires, in addition to the services of the engineers, assistance from geologists, economists, meteorologists, and many others. The scientist on the other hand often works alone or mainly with other scientists.

4. Professional engineers must devote their attention to problems which they

know will affect the lives of men in the future, while the technicians deal mainly with the problems of the day. The early civil engineers who laid out the railroads affected the lives of men for generations; since, in the design of the railroads, they indirectly established the locations for some of the great cities of today.

5. Like other professional men, the engineers must accept the responsibility of lifelong learning in order to keep pace with technical and social advances in their area of interest.

6. Professional engineers also must develop a keen sense of values and standards. Appreciation of human, moral, social, aesthetic, economic, professional, and of many other values is a necessary part of the engineer's make-up.

These are only six of the main factors which characterize and in some respects distinguish the professional engineers and their work; they should be kept in mind, along with the definition of engineering, during the remainder of this discussion.

II. *Other Functions Performed by Engineers*

There is no doubt that the education received by engineering students prepares them to perform with significant success many functions other than design—such as management, sales, operations, and maintenance. A great many engineering graduates have distinguished themselves in the management of industries, and many have risen to high executive positions.

The feeling has grown, especially among this group, that the subject matter of instruction should be changed to contain more knowledge of the actual procedures of management—even of top management—of finance, marketing, inventory control, etc. This influential opinion has had the effect in some instances of diluting the engineering programs with courses not directed toward meeting the main objectives of engineering as set forth above. The question then naturally arises: What percentage of graduating engineers actually pursue engineering work?

It is most difficult to acquire data relative to the classification of the work of engineers in industry and other organizations. As a result of discussions with many engineering educators and industrial people, it appears to me reasonable to assume that the graduates of engineering programs who pursue engineering as a career are distributed in the following manner:

Designation of Engineers	Percentage
1. *The Engineering-Scientist* These engineers are creative and discover new facts about engineering systems. This category also includes many engineering teachers.	5 to 10
2. *The Creative-Design Engineer* These are the creative individuals who actually design new engineering systems and put newly discovered principles into use.	10 to 20
3. *The Functional Engineer* These engineers employ orthodox methods and established principles in the design of conventional details of manufacturing plants and public utilities and they build, operate, and maintain these plants and their equipment.	40 to 50
4. *The Engineer-Technician* Engineers in this group devote their attention to the more routine tasks such as drafting, testing, inspection, record analysis, chemical and metallurgical analysis, etc.	10 to 20
5. *Engineers in Non-Engineering Work*	5 to 10
6. *Executive and Administrators* A large number of engineers in each of the above categories find themselves 10 years after graduation in executive, administrative, or ownership posts in industry, government, and utilities.	

All of these engineers are of vital importance in our modern society since each has his particular task to perform. The results of their labors account in large measure for the great industrial growth of America.

Let us assume that many of the graduating engineers elect functions such as management and others which are not strictly engineering according to my definition. It then becomes apparent that for every 100 engineering graduates only a few will be in the engineer-scientist and creative-design engineer classifications.

III. The Dilemma of the Curriculum

We now find ourselves in an apparent dilemma! We are asked to set up a curriculum that will provide education for several classes of engineers as well as for those who have no intention of entering any area of engineering. The difficulty is further compounded by the fact that many of the students are not mature enough even as seniors to decide what their particular life work shall be.

I would offer the following tentative proposal to meet this seemingly difficult requirement: Let us provide the basic education needed for professional engineering as defined above in the knowledge that many more such professional men will be needed in the future and in the belief, so largely confirmed by past experience, that such education—as much as can be comprehended—will be of the greatest value to all "classes" of the engineering "fraternity" as well as to others who wander from the fold of engineering. At this time it is not clear to me that any other type of education is more helpful as a general preparation for anyone who must find his way in the industrial world of the technological future.

For the remainder of this discussion I would like to present the fundamental concepts or elements which should be used to effectively design sound educational programs for professional engineers.

IV. The Design Elements for a Program in Engineering Education

The first of these is the *learning process.* Under this heading should be considered motivation. Many of our freshmen engineers arrive on the campus with enthusiasm for the enginering profession. Instead of keeping their interest in engineering at a high level, we have a tendency to reduce it by assigning too many non-engineering courses in subjects that seem to the freshman to be unrelated to his profession. At Purdue we intend to alter the freshman year by introducing a basic enginering course which will be designed to increase their enthusiasm for engineering and at the same time show the importance of chemistry, mathematics, and English for later engineering work.

Next come the *laws of learning.* Few of the freshmen have a clear understanding of the learning process, which includes such items as proper study habits, retention curves, etc. In order to introduce them to these important matters and at the same time strengthen their interest in engineering, we expect to use concepts such as a circuit analogy, etc. In so doing we will be able to show these essential factors in terms of an engineering system.

We hope to present to the student many experiences in deductive and inductive reasoning starting in the freshman year. It is felt that by careful integration of subject matter considerable success will be achieved. Every effort will be made to impress upon each student the importance of education as an individual affair. The student must be persuaded that if he does not have the basic desire to learn, his failure is inevitable.

It is hoped that during the four-year period we will be able to impress upon him that life-long learning is essential for true success. Too many of our graduates feel that commencement is the terminal point in their education.

According to our studies the second basic element to be considered in the design of the enginering curriculum is the development on the part of the student of a keen *appreciation of the languages*

of engineering. The basic language is, of course, the native tongue. A reading knowledge of one or more foreign tongues would be advantageous. One of the fundamental needs, therefore, is greater facility in the use of English—both oral and written. Few of our students are afforded an opportunity to develop skill in oral expression. A study of this matter will enable us to improve existing procedures.

The pictorial aspects of the modes of expression by engineers are drawing and sketching. Engineers need not devote hours to the development of skill in producing precise drawings, as this is becoming the realm of the technical institute graduate known as the draftsman. Engineers should be proficient in sketching so that they can rapidly portray their ideas to the draftsman or machinist.

The symbolic phase of the language of engineering consists of the students' skill in mathematics as applied to engineering. Mathematics is a tool used by engineers, and as such should be taught as an application course.

The third design element of an engineering curriculum is the *understanding of natural laws and concepts.* Greater integration of subject matter is required in the basic engineering courses. The natural laws presented in physics, chemistry, psychology, etc., should receive greater emphasis.

In many of the technical courses considerable time is devoted to studies of existing engineering equipment. Our goal is to develop capable engineers for the design problems of tomorrow. The equipment of today may become obsolete; hence time devoted to detailed descriptions could be more effectively used on enhancing the students' understanding of basic principles.

The fourth design element is *appreciation of engineering* as defined.

Engineering is both an art and a science. All problems in engineering are not solved by means of equations or technical data. In many instances a great deal of experience is required. Oftentimes the force fields are so extensive that one cannot deal with them by analytical methods. For example, in making the final selection of the site for a dam the chief designing engineer must utilize his wealth of background knowledge together with the information from reports prepared by specialists such as: geologists, soil mechanics experts, meteorologists, structural designers, economists, electrical distribution engineers and flood control experts. During a four-year program of undergraduate study it is not possible to teach the student the art of engineering; however, he should be made aware of its importance.

The fifth design element is the *general mode of analysis.* Ideal and actual systems should be distinguished from one another.

The essential steps of the general mode of analysis are: (1) preparation of statement, (2) establishment of the ideal system, (3) specification of the boundary, (4) application of fundamental laws and knowledge, (5) prediction of the behavior of the actual systems, and finally (6) study of additional systems. Of course the general mode takes on special forms in particular areas of application.

There are four general methods of attack: experimental, analytical, the use of models and analogs, and finally what might be called art. By art I mean the application of judgment based upon experience.

The sixth "design element" is that of *laboratory experiences.* During the four-year program the student will work in many different laboratories, ranging from the open campus in which he performs his freshman surveying work to the power plant where he tests a complete engineering system.

The seventh element is *knowledge of the properties of materials used by engineers.* The engineer is always confronted with the wise use of materials, and, in addition, he must eventually have an understanding of their costs and availability. Throughout his educational program the student

should receive instruction with respect to the many types of materials used in the fabrication of engineering systems.

The eighth element is *skill in mensuration and computation.* The engineer is required to be familiar with various types of measuring instruments and their use. The proper measurement of such variables as time, distance, area, pressure, temperature, resistance, voltage and flow is a vital part of the engineer's storehouse of knowledge. The exercises in the surveying courses constitute an experience in the use of instruments for measuring lengths, areas, and angles. During any laboratory period the student should take every opportunity to acquaint himself with all types of instruments, such as electron microscope, spectrograph, oscillograph, transit, chronograph, and strain gage equipment.

The engineer is constantly confronted with several systems of symbols and units used for the designation of the physical quantities. Since no standard set of symbols or units have been agreed upon by all engineers, the student should begin to develop skill in transferring from one system to another. He should not complain when one instructor uses one set of units and another a different set. He must accept this as a challenge to develop skill in understanding all of them.

By their very nature engineering problems require computations; hence skill should be developed in the use of computers. The engineering student often starts to use a computer in the sophomore year, the slide rule. He should be encouraged to become familiar with all types of computers in use on the campus during his stay at the university.

The ninth element is *knowledge of regulation and control.* All modern engineering machines, processes, and circuits involve some kind of control or regulating instruments. The student should be encouraged to study the types of instruments and controls used in all parts of systems; for example, in a modern automobile one finds: the ignition switch, gearshift mechanism, speedometer, oil gauge, battery charge or discharge meter, fuel gauge, light switches, etc.

Many opportunities should be afforded the student to observe control systems in the laboratory. Inspection trips should be arranged to industrial plants for the study of actual regulation and control systems.

The tenth element is acquaintance with *industrial processes.* Modern industry uses a multitude of processes for the manufacture of end items. It is essential that the student have an appreciation and understanding of some of these. In the limited time available, it is possible only to introduce the student to a few of them in the laboratories, such as the manufacturing process laboratory.

Students should be encouraged to take full advantage of inspection trips and to seek summer employment that will enable them to become acquainted with the operation of some of the important industrial processes.

The eleventh element is *appreciation of values.* Before he can enjoy the status of a respected citizen in his community and become a worthy member of his profession, the engineer must have developed an appreciation of certain values: human, moral, social, artistic, economic, and professional.

He should endeavor to understand the actions of his fellow men and try to realize why they behave as they do before the problems which confront them, and with this understanding should come good will. He should seek to recognize and to cultivate truthfulness—honesty—integrity—especially in intellectual areas such as his own work. He should develop a strong sense of loyalty—to his fellow workers, to his employers, to his profession, to his country. He should contribute his best effort toward the various worthwhile cooperative undertakings in his community. He should develop an interest in school systems, local governments, etc. As a good citizen, he should study current events and take seriously his obligation

to vote. He should seek an understanding of music, art, drama, etc. This will help him to appreciate the aesthetic qualities of his own work as an engineer. The student should develop an appreciation of economic values; for example, the value of new discoveries and inventions. Indeed, without this he cannot be an engineer. Every student and engineer should have a pride in his profession and contribute ideas that will help to enhance the standing of engineering. The student should be encouraged to join a student engineering society before graduation and to take part in its activities, seeking, if possible, to improve them.

The sense of value is an awareness and a conviction that one gets from others who have it. It can be shared but not legislated into existence. The opportunity of the college to help the student in this area therefore depends primarily upon the teachers—the quality and intensity of their sense of values. The curriculum, itself, is of secondary importance.

The final element of my list is the *integration of subject matter for design.* As the student progresses he should be encouraged to be on the lookout for ways and means for correlating and integrating fundamental knowledge. The more of this he can do, the stronger his foundation will be. For example, there are certain basic laws and relations which describe the flow of electricity in a circuit; many of whose equations apply also to the flow of a fluid through a pipe or the flow of heat through a building wall. The techniques for solving the one set of equations are, of course, essentially the same as for the others.

When or if we succeed in combining in proper proportion and emphasis the twelve basic elements herein proposed, then we shall have developed an appropriate curriculum for the engineers of the unpredictable but almost certainly trying times just ahead.

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National Science Foundation Offers Graduate Science Fellowships

College seniors and graduate science students can submit applications for the more than 750 fellowships for a year of graduate study during the 1956–57 academic year. Applications can be obtained from the Fellowship Office, National Research Council, Washington 25, D. C. Closing dates for receipt of applications are December 19, 1955, for postdoctoral applicants, and January 3, 1956, for graduate students working toward advanced degrees in science. Selections will be announced March 15, 1956.

Where Are We Going in Engineering Education?*

By R. L. SWEIGERT

Dean, Graduate Division, Georgia Institute of Technology

In any discussion of engineering education there appears to be two points of view possible, one of which leads to education for a learned profession, the other, to a general type of education that is supposed to be good preparation for a variety of activities.

A letter that I recently received asked this question about engineers: are we tradesmen, technicians, or members of a learned profession? This question is going to be answered as time passes whether or not those of us concerned with engineering answer it. Outside influences will produce an answer for us if we do nothing or little about it, and we may not like that kind of an answer!

Our unwillingness to have provided an answer to the question is helping the movement towards unionism and unionism can hardly be classified as part of a learned profession. A leading labor-leader before a Senate Committee stated that he had been unable to find any distinction being made between the technician and the engineer, and that as far as he was concerned, the technician, the engineer, and the man working at a lathe were all the same.

If engineering is a learned profession, and I believe that it is, then it can be defined in terms that will indicate such a condition. Before we can proceed with the development of a better profession and better professional engineering education, the profession must be explicity defined. Without it being carefully defined how can we carry forward engineering education? If engineering education is to be preparation for a profession then what must be the prime consideration.

I would like to point out two things. First, there has been no scientific type of evidence that shows that engineering education is a good preparation for most anything; and second, there is no other place for one to get a professional engineering education than in an engineering school, but there are other educational places for those entering other types of activities. Therefore our prime concern should be for the young man who desires an education that will prepare him to become a professional engineer and this should receive first consideration regardless of the fact that we will always have a number particularly at the undergraduate level who will go in other directions. Some professional engineers may become administrators. Administration should not be regarded as the end point for a professional engineer. If engineering is to be a worthwhile profession, it must stand on its own feet. Young men should enter the study of enginering because they have a strong desire to be professional men of the highest competence in the practice in the profession. If its function is to be a stepping stone then it doesn't deserve a place amongst the learned professions. We will not have the profession that we should have until our engineering education is directed primarily towards preparation for the profession and we

* Paper presented at Annual Meeting of Missouri-Arkansas Section, American Society for Engineering Education, Columbia, Missouri, March 26, 1955.

look upon becoming a top engineer as a final goal in itself. Engineering should and can stand upon its own feet.

Now how can we define engineering so that it will show that it is rightfully one of the learned professions? To be a profession there needs to be something distinctive about it. Careful examination shows that design is a prime characteristic. But there are all kinds of design. Therefore it must be carefully specified. We can say that professional engineering includes the functions of research leading to design; development, which naturally leads to design; and creative design based upon the application of mathematics, the physical sciences, and any other appropriate sciences. I believe this definition makes the profession of engineering distinctive, separating it from technician level work and from the work of the scientist. It also indicates the characteristic of a learned profession involving extensive educational preparation. Professional engineers may perform professional work in other functions where the same full knowledge of design is called for. Such functions however should not be classified as engineering functions. Professional engineering is creative and covers design of devices, systems, and processes.

The work of the technician with which professional engineering practice is frequently confused, is different. It is not creative but is routine and repetitive in character. Technicians function in operation, maintenance, service, production, installation, and sales. They follow the professional engineer's instructions and perform repetitive calculations and other repetitive operations.

I suspect in the light of the definition above the engineering schools have turned out a high proportion of technicians. Two year Technical Institute graduates can take over many technician jobs but we also may need a number of four year technicians, and it becomes a problem of the future whether or not we should train technicians in professional engineering schools although probably there will always be a number of four year men who may not be able to become professional men and therefore can perform a much needed work at the technician level.

Becoming More Scientific

As we note the direction that the engineering profession appears to be moving, that while it remains an art, it is nevertheless becoming much more scientific. As science advances the profession must also advance in the same way or otherwise the scientist must step over into the engineering field as has frequently been the case.

Coming back to our definition, if it is accepted, then we have the direction indicated that our engineering education programs should take.

It is evident that if we are concerned with design based upon mathematics, the physical sciences and other appropriate sciences, then our programs should provide that background in such a manner that it is useful; that means giving at least an amount upon which one can build effectively.

Certain sciences due to their extensive engineering use have become known as engineering sciences. There are six of these of importance to prospective engineers at the present time and therefore of importance in engineering education. These engineering sciences call for a background in mathematics and science. The engineering sciences should be given using the sciences and mathematics.

Following this background the student should be prepared to take up analysis and be initiated into creative design. It should be noted that the undergraduate student can only be introduced to the engineering sciences in a four year curriculum, and the creative design courses are naturally limited to this introductory level. The four year program is preparatory, not professional.

While the suggestion of bifurcation seems to be thoroughly frowned upon, nevertheless the idea continually rears its head. We are confronted with two classes of functions for which we have

been preparing young men; the professional functions already mentioned and such other broad non-professional functions as service, operation, maintenance, sales, engineering aid, etc. These differences can be provided for by electives which in operation then become equivalent to bifurcation. Those not going into strictly professional functions do not appear to need as much science, mathematics, or engineering science, while those with professional objectives would need the science and mathematics.

An appropriate sequence of general subjects is also part of the educational picture but if we keep in mind Sir Richard Livingston's philosophy we will not dilute our programs to the extent of harming the strictly professional preparation. Sir Richard Livingston is an outstanding liberal arts educator in England. He states to profit from liberal studies, a student needs a life background upon which to understand and interpret such studies. Maturity is essential. Liberal studies should receive more attention at the graduate level. At present they receive almost no attention.

Since the preparation that we have been talking about is essentially preprofessional, it must be followed by advanced professional study at the graduate level or by equivalent individual study. Young men with the necessary energy, drive, and persistence can gain this professional education themselves but I believe that it will become more and more apparent to such men that they can gain their objectives better by graduate study in engineering at a qualified engineering school. Let us move in the direction of adequate and full preparation for the profession. The pressure for off-campus graduate work in engineering shows the need for this preparation.

Before leaving the discussion of programs I would like to refer again to the fact that the principle background for engineering comes from physics, and chemistry with the use of mathematics as a tool.

With this condition, at the undergraduate level we might need to be confronted with only two programs, one based primarily upon physics and one based primarily upon chemistry. This would eliminate the fragmentation that we now have.

Such undergraduate programs would give excellent preparation for professional study at the graduate level where the students would enter more specifically into mechanical, electrical and other applied fields. Professional graduate study should be essentially advanced study of appropriate engineering sciences along with work in creative design and research. Through the thesis we can perhaps approach as closely to the art of engineering as can be done on a campus.

Shortage in Brainpower

We should be concerned about a shortage in engineering brainpower rather than a shortage in bodies. We have not educated our prospective engineers to the level to enable them to function the most effectively in modern engineering practice.

We have done all right in training technicians and a rather high proportion of our Bachelor's men have become technicians. They are doing a needed work but are not creative.

We need the right combination of students, faculty, facilities, programs, and money to produce the most effective education possible for professional engineers and also for four year technicians which undoubtedly we will continue to train for some time. What finally may be the full impact of technical institutes is not clear, but their development may change some of the things now going on in engineering schools.

We need better students resulting in reduced attrition, more professionally and scientifically minded faculties, more creative faculties, more scientific and fuller developed programs to the top level, and appropriate facilities to develop understanding, know-how, and creativity.

Perhaps we can make a rough comparison between 1900, 1950, and the year 2000. In 1900 most of the engineers had no college education and perhaps a degree was looked upon with some disfavor. Today, Bachelor's degrees are the rule and the doctorate is the more rare level to-day.

If some of the present trends continue, by the year 2000 it is quite possible that professional engineers will be coming out at the doctorate level.

Then because of the extended period of education and a recognition of its level, engineering will become much better recognized as a learned profession which it appears difficult to bring about to-day. It will be much easier to separate union activities from the profession.

Let us put aside that part of tradition that holds us back and let us advance engineering to a recognized unified learned profession. This we can do if we all put our shoulder to the wheel. Let us all look to the future to one of the finest of the learned professions.

College Notes

A teaching professorship in chemical engineering, believed to be the first industrially-sponsored university chair specifically limited to undergraduate instruction, will be established at **Cornell University** with funds given by Socony Mobil Oil Company, Inc.

Dr. Charles G. Overberger has been appointed head of the Department of Chemistry at the **Polytechnic Institute of Brooklyn.**

A Department of Industrial Engineering has been added to **Stanford University's** School of Engineering. Professor W. Grant Ireson will head the new department which offers studies leading to degrees of bachelor of science and master of science in industrial engineering.

The Place of Solid State Physics in Engineering

By H. V. FAIRBANKS

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Introduction

Much is known about the laws which govern gases and liquids, but only in recent years has extensive work been done to discover the laws and in particular the mechanisms which govern the behavior of solids.

In engineering, solids are one of our major materials, if not the major material, with which we work. For years we have dealt empirically with such properties as creep, fatigue, corrosion, electrical resistance, magnetism, wear, hardness and strength of materials. Today through the use of solid state physics, we have been able to approach some of our problems in a more direct scientific manner. And as our basic knowledge in solid state physics increases, more problems are solved and better yet, new applications for the solid materials are found.

This shift of the technical base of engineering from one which was largely empirical to one which is scientific has increased the importance for engineers to be well grounded in the basis sciences. The body of scientific knowledge in these fields, as we all know, is growing very rapidly. But of more importance to the engineering profession is the equally rapid decrease of the time interval between a discovery in pure science and its practical utilization.

History

In regard to solid state physics, let us take a look at the developments over the past years which have helped to create this important branch of science. Starting back in 1869, we find that Mendelyeev arranged the elements according to their atomic weights into a chart known as the periodic table. From this arrangement, the periodicity in properties of the elements were noted. This led to predictions as to what properties one might expect when the elements were added to a metal to produce an alloy.

In 1876 Gibbs formulated his phase rule which has aided us in our knowledge as to what factors influence a given system. Among its many uses, it has served to define the eutectoid as a point instead of a line on the iron-iron carbide phase diagram.

At the turn of the twentieth century, many scientific discoveries were made which have had a direct bearing on our present day science of solid state physics. Among these are Rontgen's observation that cathode rays impinged on matter produced X-rays, Madame Curie's isolation of radium and study of magnetism, Thomson's experiment which proved that cathode rays were made up of negatively charged particles, Plank's quantum theory, and Einstein's famous equation relating energy to matter.

With this as background, Lord Rutherford in 1911 conceived the modern nuclear theory of matter. Two years later, Bohr expanded this theory by introducing the idea of energy levels for the electrons. Lorentz in 1916 extended the theory of Drude for the solid state of metal. His theory stated that metal crystals are made up of ions which are held together by a free electron gas.

In 1925 wave mechanics was introduced for the study of the mechanism of atoms. Also in that year, Pauli announced his exclusion principle which stated that no two electrons in the same atom may have their four quantum numbers identical. During this same year, Hume-Rothery

formulated his famous rule of electron concentration which generally determines the type of crystal lattice system for metals in the solid state. For example, the electron to atom ratio of 3:2 is found for a body centered cubic; and a 7:4 ratio for a close-packed hexagonal structure.

In 1938 the theory of metallic bonding was greatly expanded by Pauling. He stated that the electrons which bind the metal ions together are in resonance between the ions due to the fact that there are unfilled orbits in the metal atoms.

Within the last 20 years, several symposiums and conferences have been held, and numerous articles and books have been written upon the subject of the solid state of matter. The most recent ones have dealt with the imperfections found in the solids. Many explanations have been made to show how these imperfections affect the properties of the solid materials.

Applications

Now let us look at some of the applications that have come from these theories. The constant value of resistivity of Constantin over a rather large temperature range has been found to be due to the release of trapped electrons by nickel in the third layer as the temperature of the metal is increased. The low coefficient of expansion of Invar over a given temperature range makes use of the contraction effected by part of the material changing from the magnetic state to nonmagnetic state which offsets the normal expansion caused by raising the temperature. Making use of this knowledge, other alloys have been fabricated which have better properties than either Constantin or Invar.

Using our present physical theories, one comes to the conclusion that a perfect metal crystal should have very little if any resistance to passage of electric current. It can also be calculated that metals should be 100 to 1000 times stronger than they are. The question arises: What causes this discrepancy between our theories and actualities?

The answer seems to lie with the imperfections which have been found in the metal crystals. These imperfections give rise to higher than normal electric resistances and weaker than normal strength. The imperfections may be of many kinds, such as impurities, dislocations and vacancies. Recently a method has been used which pretty well eliminates the impurities. These extremely pure metals are found to have lower electrical resistance and are extremely strong when of microscopic diameter. However, for normal sized masses of material it was found that the dislocations and vacancies within a crystal apparently have a definite equilibrium value for any given temperature and pressure.

Vacancies determine the rate of atom diffusion and play an important role in the sintering of compressed metal powders. This is of commercial importance in the fabrication process called powder metallurgy.

As for dislocations, these are extra sheets of atoms which may contain between 10 to 10,000 atoms and are squeezed between but do not go all the length of the regular layers of atoms making up the crystal lattice structure. They produce stresses in the areas where located and make voids in the end spaces adjacent to them. Foreign atoms migrate to these areas and fill the voids locking the dislocations into place. This factor of locking dislocations into place is what causes the horizontal wavy portion of the stress-strain curve for mild steel when the proportionality limit has been exceeded. The explanation is as follows: (1) The stress applied to the metal causes the dislocations to move. (2) However, they are initially locked into place by the carbon atoms; therefore, a more than normal amount of force is required for the dislocations to move. (3) When once moved they then move easily until they replace the position of another dislocation. (4) The carbon atoms again lock the dislocation in place and as the plastic deformation proceeds, the process is repeated several times.

It has been estimated that under equilibrium conditions or in the annealed state 10^9 dislocations are found in a cubic centimeter of a metal crystal. After severe cold working, 10^{11} dislocations per cubic centimeter are present. Plastic deformation, therefore, not only moves the dislocations but increases the number of dislocations present in the metal. These dislocations move along many directions within a metal crystal and meet like automobiles at a street corner until there is a traffic jam. The resistance of dislocations to move across each other at these traffic jams causes what is known as work hardening of the metal. If further stress is applied, dislocations can be made to cross each other and large voids are formed. These voids may be seen at the break of a bar of rectangular cross-section which has been pulled in a tensile strength machine.

We at West Virginia University are carrying on a research program in which we are measuring the amount of voids created by cold working of the metal through tension. This is obtained by measuring the resulting decrease in density and checked by X-ray diffraction.

The theory of dislocation also explains why metals are not as strong as calculated. The mechanisms of movement of a dislocation is one which involves 10 or more adjacent atoms instead of a whole plane of atoms. In order to produce a movement of one atomic spacing both the top and bottom layers of atoms move and each atom involved may move only $\frac{1}{20}$ of an atomic spacing. This greatly reduces the force required for the plastic deformation. This mechanism of movement also accounts for the fact that metals do not fracture when deformation takes place.

Let us now turn our attention to other phenomenon which have been aided by solid state physics. It has been found that the first stage of creep may be considerably reduced by putting in low angle grain boundaries and by coarsening the grain structure. This may be accomplished by prestressing the metal 3% followed by annealing. In the field of electrical engineering power losses in transformer, motor and generator cores are being reduced by crystal orientation of coarse-grained 3.5% silicon sheet. The processing is similar to that just mentioned.

In the field of plastics, we find that the solid state may be amorphous, crystalline or a combination of both. If the plastic forms a floppy chained polymer, it tends to be amorphous. If the polymers have a regular structure, it tends to be crystalline. When testing the tensile strength of plastics, we find that there are three stages: (1) removal of the initial slack, (2) straightening of the chains, and (3) slip of the chains past each other. Recently a chemical company has been able to control the crystalline structure of nylon. This allows the nylon to take on added properties and opens up new fields of application for it such as, gears, bottles, valves, and machinery housing.

In another field of solids, we find that water is the solidifying agent. In concrete there are two types of water present: (1) gel water which is the water of hydration and (2) capillary water. The amount of gel water accounts for the shrinkage and expansion of the concrete due to temperature changes.

The amount of extra water used in concrete mix determines the number and size of capillaries. The larger the capillaries the weaker becomes the concrete therefore, it is best to have as dry a mix as possible. Also it is the freezing of the capillary water that causes concrete to crack in winter. To remedy this, we put air bubbles in the concrete which allows for the expansion of the freezing capillary water.

Solid state physics has played an important part in the development of many fields which have been well publicized such as nuclear energy, magnetism, transistors, solar batteries and the light amplifier. This is only the beginning of many applications to come.

Where in Curriculum?

Now the question arises how and where can we put the material of solid state physics into an already crowded engineering curriculum. An answer may be found from the report on the Carnegie Conference on the Impact of Solid State Science on Engineering Materials.* The following suggestions were made:

A. Enrichment of existing courses in the curricula with solid state science material.
B. Replacement of a specific portion of the present appropriate courses with up-to-date material.
C. Utilization of available advanced physics courses as electives.
D. Establishment of specific new courses in solid state physics.

It is my thought that the Physics Department should handle the pure science phase of the solid state by incorporating this subject matter into the regular physics courses. I am also in favor of having 3 or, better still, 4 semesters of fundamental physics required for all engineers. A few schools have been doing this for several years.

The applied phases of solid state physics should be taught by the engineering instructors. This means possible replacement of a specific portion of some courses with up-to-date material. And in other cases, it would mean enrichment of existing courses with applications of the solid state science.

To emphasize my point of view, I would like to quote from Dr. N. H. Frank, Head, Department of Physics, M.I.T. from a recent article published in the *Journal of A.S.E.E.*†

> In short, physics courses should be pure physics and applied physics should be taught by the engineers . . . clearly the mere addition of the factual matter of modern physics and of modern physical theory to the traditional courses can lead only to dilution and superficiality. I submit that we need surgery; we must be willing to cut out much of the traditional, albeit solid, subject matter of physics, use modern physics to supply the illustrations of the basic principles, shift the emphasis to the broad conservation principles and their implications, integrating them into a unified structure, and drop the conventional divisions of physics.

On the engineering side of the picture we have a similar job to accomplish. There should be a re-evaluation of courses and their content. A lot of so called solid material could be removed and replaced with up-to-date subject matter. The tools for engineering are changing. As was stated before, the technical base of engineering is changing from the empirical to the scientific. Engineering education must therefore change to keep pace with the times and to provide these new tools which are so necessary to our profession. As to the actual integration of solid state physics into our present engineering curricula, we must face this educational problem in the same spirit with which we face any new problem in engineering.

Conclusion

The present limitations to many engineering developments are a direct result of the limitations in our knowledge of the properties of solid materials. Therefore, it would be well if all engineers could acquire some basic knowledge of the solid state science. It is especially needed for the research and design engineer and is well worth while for the production engineer as he will then be better equipped to make use of the developments which stem from the application of Solid State Physics.

* G. Murphy, "Report on the Carnegie Conference," *Journal of Engineering Education*, Vol. 45, No. 5, Jan. 1955, p. 418.

† N. H. Frank, "The Responsibility of the Physics Teacher in Engineering Education," *The Journal of Engineering Education*, Vol. 45, No. 3, Nov. 1954, p. 243.

Recognizing Potential Engineers Among Science Students

By ROBERT DOUGLAS MacCURDY,
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The Situation

America is facing a dire shortage of scientists and engineers. This has been the subject of numerous reports by such writers as John M. Gillette, Harley M. Kilgore during the second session of the 79th Congress, M. H. Trytten in *The Scientific American,* and the National Manpower Council. Comprehensive and detailed studies by many investigators have shown that scientists are different with enough specific character traits to make identification easy. Career choices for science are made while the student scientist is young. It is this writer's opinion that a way must be found to identify the future scientist before he makes his career choice and thus interest him and guide his training so that all potential future scientists are developed to their maximum capacity. Information from the Science Clubs of America has shown that 94 per cent of the winners of the Science Talent Search followed their occupational choice and became scientists, engineers and professional people. It appeared that these were a few of those rare key people, yet in the embryo state. The identification and classification of their characteristics and background factors became the problem to solve.

The Procedure

Developing the instrument.—By utilizing the findings of all previous studies, the writer's personal experience, the opinions of consultants, pilot studies of trial and error, an inquiry form of 300 items was developed. The writer received invaluable help from the creators of the Science Talent Search and Science Clubs of America in developing the instrument and sending it to the respondents. These were mailed to the respondents and the return after two months was 85 per cent.

The respondents.—There were two groups of respondents, as follows:

A control group of 78 freshmen and sophomores of high general ability. Their IQ mean was 129. In many ways they were similar to the test group, however, they were generalists rather than specialists in science.

A test group of 600 freshmen and sophomores of high special ability. Their IQ was not known accurately but suggested to be around 140. These were the Winners and Honorable Mention Winners of the Science Talent Search for 1952 and 1953.

Analysis of the data.—The IBM answer sheets for the questions in the inquiry form were sorted according to occupational choice making five groups: scientific scholars, potential scientists, potential engineers, women in science and potential professional people. The responses were tabulated electrically by an IBM item tabulator. The total "yes" responses for each question were converted to percentages. The percentage response of each of the five sub-groups and the whole test group (504 superior science students) on each item was compared with the similar response to the same item-answer by the control group. The differences in percentages were tested for significance by

TABLE I

OCCUPATIONAL CHOICES 110 ENGINEERS (POTENTIAL)
HONORABLE MENTION, MEN

Title of the chosen occupation (1)		No. sub. per cent (2)	No. total (3)	Per cent (4)
Engineer, electrical			36	32.7
Engineer, electrical unspecialized	15	13.6		
Engineer, electrical electronic	16	14.5		
Engineer, electrical auto control	5	4.5		
Engineer, chemical			29	26.4
Engineer, mechanical			9	8.2
Engineer, aeronautical			9	8.2
Engineer, physics (combined)			8	7.3
Engineer, nuclear			5	4.5
Engineer, unspecialized			5	4.5
Engineer, architectural			3	2.7
Engineer, industrial			3	2.7
Engineer, civil			2	1.8
Engineer, geological			1	.9
Totals			110	99.9

the methods of Palmer Johnson.* Multiple choice items were analyzed by Chi Square. Items of significance at the five per cent level or more were selected as qualifying items of characteristics and background factors.

Results

Tables and portraits.—The occupational choices of the test groups, Table I, and the control group, Table II, were tabulated and reported. These verified the interest of the respondents in the special field of science and the general field of life activities. There were over 150 of the 300 items that were significant at the five per cent level for all groups. Many were related to each other being merely different aspects of the same quality. They were, therefore, grouped into eight general categories: personality, attitude, interests, activities, family history, associates, science teacher and decision for science. The items in each category create the portraits of the superior science students and their own sub-groups.

Characteristics of Potential Engineers

The portrait appearing below describes those characteristics and background factors of 110 Honorable Mention Winners of the Science Talent Search who have chosen engineering as their profession. These items are significantly different at the five per cent level from those characteristics and background factors of their contemporaries in general education. The portraits were developed like those in other studies by grouping significant items under related general categories. The number following each item shows the *percentage* of the group that responded positively to it.

Personality

The potential engineers appeared to be *leaders* for they enjoyed being group leaders in science 69, they liked to assume responsibility 80, to organize and lead field trips 64, hold office in a science club 42, or be elected an officer in student gov-

* Palmer O. Johnson, "Statistical Methods in Research," Prentice-Hall Inc., New York, 1949, p. 165.

ernment 43. They were *self-disciplined* and had good control of themselves, they did not attempt more than they could complete 72, made a determined effort to always be punctual 75, did not depend on their own memories to be unusually reliable 58, did not dislike hard work and long hours on self-assigned tasks 88, did not have occasion to regret losing their tempers 61. They were *serious minded, practical and materialistic,* they did not find people calling them day-dreamers 70, did not have dates with girls as often as twice a week 93, did not want to be like athletes 94, but they liked to solve mental puzzles and riddles 84 and usually sought causes for all effects 72, they had a *lively curiosity* about the natural world 89.

Attitudes and Opinions

The potential engineers have an *attitude of suspended judgment* for though they usually persisted tenaciously on a job to its completion 65, they quickly changed their opinion if proved wrong 78, and they consciously separated their judgments from their likes 78. They are *not solitary and self assured* in their outlook for while they always gathered their own facts 37, they got real help in science from someone else 72, and did not conclude that a person is responsible to himself alone 90. They believed in *no superstitions* 91, did not participate in the usual games of chance 59 and did not let events of chance plan their lives 78. They are *not agnostic or atheistic* for they do not question the soundness of religion 49 and willingly go to church twice a week or more 88. Their *social views on the application of science* are a bit unusual for they question the use to which science is put 77, decided that scientists and science students were so scarce and so valuable that they should not be drafted for military service but kept in their scientific work or study 56, but at the same time scientists should not ignore promotions 96.

Interests

The interests of the potential engineers are *rather narrow and specialized.* They are *partly mechanical* such as an interest in radio-ham operating 76, hi-fi and radio set building 81, handwork, crafts and

TABLE II

OCCUPATIONAL CHOICES—78 CONTEMPORARIES IN GENERAL EDUCATION (CONTROL GROUP)

Title of the chosen occupation (1)	No. total (2)	Per cent (3)
Undecided	19	24.0
Writer-journalist	11	14.1
Teacher, college or high school	9	11.5
Businessman	6	7.6
Entertainer, radio-TV	5	6.4
Dentistry or medical practice	4	5.1
Lawyer	4	5.1
Civil service	4	5.1
Psychologist	4	5.1
Engineer	3	3.8
Scientist	3	3.8
Social worker	2	2.6
Medical service (female)	2	2.6
Theologist	1	1.3
Secretary	1	1.3
Totals	78	99.9

carpentry 89, mechanics, tinkering and repairing 92, model building, boats and planes 76, photography 87. It is *partly scientific* such as an interest in reading science 97 and science fiction 69, inventing 95, and science studies on projects 95. It is not surprising to find that they are also interested in *scholarly things* such as a study of courses in school 79 and playing chess 73, outdoor life in scouting activities 74 and astronomy 83.

Activities

The activities of the potential engineers are the behavioristic expression of their attitudes and opinions, interests and personalities. They had some *general social* characteristics such as membership in non-scientific clubs 90, elected officer in student government 43, work on school publications 59, membership in four to eight clubs, committees and societies 57, but no athletic team membership 51. There are some activities that reveal their *scholarly* characteristics such as belonging to an honor society 82, never failing a course 93, never expelled for disciplinary reasons 97, accumulated less than a total of a month's absence during high school career 85, on the honor roll 100 per cent of the time 77, and received marks that averaged A− to A+ 81. They failed to make their best marks in English 97 or their worst in mathematics 94, which they liked 91. As expected *most of their activities were in science* where they were officers of science clubs 42, belonged to Science Clubs of America 30, Junior Academy of Science 19, and scientific societies 55. They spent time regularly each week in after school science studies 46, where they planned experiments and did them themselves 80, performed some high grade scientific research 24, improved a scientific method or device 32, invented something scientific 28, published a scientific or other article 15. These activities usually *led them to compete* in science fairs 34, or congresses 22; compete for prizes in science 74, which they won 58; and a part time job in science 18. In the classroom during school hours they acted as teaching assistants 39, gave lecture demonstrations 57, helped operate audio-visual aids 59, led and organized field trips 20, went on field trips 64 and visited scientific industry 65.

Factors that were found in their backgrounds.

Family History

The potential engineer was *the first born child* 69 and *had no brothers* 55. Among *his older relatives were some scientists* 26 *and teachers* 53 but no musicians 80. His mother was born in America 85, had a college or post graduate degree 36, had *earned the admiration and respect of her son by her achievements* 82 and *did not "boss" the family* 25. *His father* had a post graduate degree 20, *was an employer managing his own business* 37, his *son admired and respected his father's achievements* 84, and the father *did not "boss" the family* 25. The family provided a *stable, comfortable and stimulating home.* The principle residence was *in a city of a million or more* 26, during high school the *family did not move or cause the student to change schools* 89. The family *bought six to ten magazines each month* 52, there was usually a home workshop or laboratory 63, *adequate workshop* or laboratory facilities were available 57, *a place to study* science at home 69. The student had *time to study* and work in science for he had leisure time to study science 86, almost enough time to study science at home 75, and did *not have an after school job* 55. The family highly praised and respected science 61 and strongly *supported the potential engineers' plans* for a career in science 74.

Associates

While the potential engineer read he found that newspaper or magazine *articles could influence him toward a career* in science 40, and that *books gave him inspiration* and encouragement to be a scientist 81, his *greatest social influence came from his associates.* He had *chums*

who wanted to be scientists 79, and he had friends *who let themselves be led in group science activities* 32, there were *older students who helped,* guided and encouraged him in his science activities 38. Even though he thought that he directed himself like a "lone wolf" in science 30, he did personally *know a scientist* 43, and *worked with a scientist* 18, and tried to behave like a scientist 38.

The Science Teacher

The science teacher of the potential engineer *quickly gained his admiration and respect* 83, he had a good sense of humor 92, was fun to be with most of the time 78, and enjoyed his job of teaching 92. He was using his greatest ability as a science teacher 52 and had a hobby 54. Probably the *admiration and respect* were based on the fact that the science teacher believed in hard work and long hours for himself 64, he stayed after-school and assisted students in their science activities 91, he *gave them opportunities to lead and organize* group activities in science 70, acted as sponsor for science clubs 76. In his classes he used lectures as his principle teaching method 35, but never discussed "The Great Scientists," 48. He was a *practical man* who had an after school job 23, and invented scientific or science teaching devices 25. He *contacted his professional world* by communicating with teachers from other schools 56, with other scientists 38, and membership in professional organizations 43.

Decision to be a Scientist

The potential engineer decided on a scientific career *when he was in high school* 29, because he had a *natural aptitude* for it 48, and it was so *interesting* 39. He felt he *could grow and develop working on important problems* 27.

Conclusions

Reason for separate conclusions.—There are over a hundred items that build the portrait of the potential engineer. The portrait is a complicated one, so each general category of the portrait has been reduced to a few general characteristics. These have been developed by combining and consolidating several items in the category to a single quality.

Personality.—Leaders, self-disciplined, self-controlled and self-critical. Serious minded and practical, curious.

Attitudes and opinions.—Suspended judgment, neither solitary nor self-assured, rational, religious, believe science can solve social problems.

Interests.—Narrow and specialized into mechanical, craftsman, shop interests. Some interest in scholarly and scientific things.

Activities.—Some social life, scholarly pursuits, scientific, mathematical, competition in science world, helped science teacher.

Family history.—First born son, older relatives in science and education, strong mother influence, family democratic and permissive. Father in business, home stable, comfortable, urban, cultured, economic advantage, time and opportunity for scientific development.

Associates.—Books and associates very influential in science. Stimulated and encouraged by a scientist and friends in scientific activities.

Science teacher.—Admirable person, set good example, permissive, practical, professional and democratic.

Decision to be a scientist.—Reached decision in high school because of natural aptitude, interest, and he could grow and develop working on important problems.

Review.—The potential engineer developed because of capacity, interest, freedom and a practical mechanical setting.

How the Report of the American Advisory Mission to Japan for Engineering Education, 1951, Influenced Japanese Engineering Education*

By DR. KINJI SHIMIZU

President, Nagoya Institute of Technology; President, Tokai Society for Engineering Education; and Vice President, Japanese Society for Engineering Education

Professor Clark D. Goodman requested to submit a document stating about the influence of the report of the American Mission for Engineering Education on Japanese engineering education to Mr. Seisuke Inada, director of the Bureau of Universities, Ministry of Education, who entrusted me to write the document. I think I am one of suitable for this work, because I proposed the organization of the Japanese Society for Engineering Education and seven regional societies and after its establishment took management for improving Japanese engineering education in the Japanese Society, in the Tokai Society and in councils in the Ministry of Education. It was hard work to manage societies effectively and in good financial state; the fact, however, was that by sacrificial efforts of several persons all projects went well and smoothly under comparatively good financial state, though not so sufficient. The Ministry of Education recognized the steadiness and seriousness of our society from first and backed us up very earnestly. Some industrial leaders also supported us very eagerly, acknowledging our enterprise as necessary and significant also for their business. Thus our works are on the track and going harmoniously. Now, reflecting the inauguration ceremony of our society, 1952, I remember the words of Dr. Hazen's message, meaning that when those who have sincere concern come together with true desire to improve for education or anything else, progress occurs inevitably. Really seven regional societies are doing their efforts for improving engineering education in each district and not quickly, but gradually we see many symptoms of appearing good educations.

1. The biggest effect of the report was the work of the Japanese Society for Engineering Education 1952 autumn; that is,

a) the report was translated and abstracted by Dr. Kinji Shimizu and the abstracts were distributed to all engineering teachers,
b) each of the seven regional societies held meetings discussing the report,
c) the discussed results at the meetings were inserted in the first number of *The Journal of Engineering Education,* which was published in April, 1953. The work of JSEE above had, I believe, following influences to all engineering teachers;
   1) Reflection for the responsibilities of engineering teachers.
   2) Awakening of their past incorrect idea for the teaching and teaching method.

* (The person submitting Dr. Shimizu's report for publication requested that it be published without editing and the Editor has abided with that request.)

3) Their idea of "research first" or "research almighty" was somewhat amended or balanced a little by good teaching.
4) At any rate, the report was a great impetus for all engineering teachers to think over how to teach or how to improve their education and to give ear to other comments or criticisms from industrial circle or from experienced educators, in spite of their past dogmatic ways.

2. *The Journal of Engineering Education,* published by JSEE twice a year, give always excitations to all engineering teachers. It includes miscellaneous comments or articles by engineering teachers or by engineers, the discussed results at meetings in regional societies, status of engineering education in other countries, data or reports for improving or contributing to engineering education. It is compiled after the Journal of ASEE, but has a special feature of having plenty of data or reports. That we had such a useful journal is an influence of the report of the American Mission.

3. Yearly in July, we hold the annual meeting of JSEE, calling many hundred teachers and engineers together where many important problems on engineering education are discussed and teachers and engineers exchange their opinions and increase their intimacy. It gives always a chance to reflect their teaching and to be ready for improving teaching. This is also an imitation after ASEE, and is an influence of the report of the American Mission.

4. At the annual meeting, JSEE proposes a theme to be discussed at autumn meetings in regional societies, which excites engineers and engineering teachers in the whole country. The discussed results are inserted in the Journal of JSEE.

5. Last year JSEE tried to make the paper competition on improving engineering education, for which 23 teachers sent their articles and two assistant professors won higher prizes, four professors and one engineer got lower prizes. This enterprise is also one method of exciting teachers and engineers, and will be continued for long.

6. JSEE held from the first its principle to work under the intimate cooperation of universities and industries. The Japan Federation of Industrial Managers always assists our work, giving data in industry and cooperating for investigations.

The Tokai Society collected opinions of industrial engineers on improving engineering education for which industry offered good cooperation; as the result, the relation between universities and industries in that district became very intimate, and the opinions served as a reference for improving education. The result will be discussed at the third annual meeting of JSEE at Nagoya.

Other regional societies are also endeavoring to make good contact between universities and industries.

7. Many engineering teachers are striving to improved their teaching and teaching method, and I believe, not so quickly, but gradually Japanese engineering education will make its progress. I am very glad on hearing the evaluation or criticism for engineering graduates from universities which became better year by year.

A Technical Writing Course That Works*

By RAY SWEIGERT, JR.

Technical Writing Staff, State University of Iowa

In the last January issue of this publication is an article entitled "Our Schools Can Teach Writing—If They Are Made To," in which J. H. Wilson, Jr., of the Editorial Branch, United States Naval Ordnance Test Station, analyzes a problem that has disturbed industry for some time. In this article, the blame for the lack of communication skills among scientists and engineers is placed squarely on the shoulders of our educators—and rightly so. Among the graduates of the few engineering schools that teach communication techniques to their students, there is no problem. Yet where the graduates of most engineering schools are concerned, ability to communicate is sadly lacking.

The Engineering College of the State University of Iowa has developed a two-semester course in technical writing. This course is at least a partial answer to this dilemma. In Wilson's article, the problem is broken down into two parts: to teach technical people the fundamentals of writing and to teach them the special mechanics of writing technical reports. The course in technical writing at Iowa has been able to deal with these two parts at the same time. Since the students in the course must be at least juniors, they know already something of basic writing techniques from struggling with the freshman course in communication skills, part of the liberal arts requirement for engineering students; and they have advanced far enough in their professional studies to have something about which to write. The course in technical writing improves and polishes the basic writing skills of the student and at the same time teaches him to employ these skills in writing technical reports.

The Success of the Course

The Technical Writing Staff is constantly modifying the course in order to make it better correlate with the needs of the engineer in industry. These modifications are based to a large extent on replies to letters sent to alumni of the Engineering College after they have been out of school for about five years. Their replies stress generally the need for technical writing as part of the engineering program, and often suggestions are made as to how the course might be improved. Members of the staff often work in industry during the summer and come back to school in the fall with new ideas for the course.

Solving the problem of motivating the students, of convincing them that the skills they learn in technical writing are a necessary part of their engineering knowledge, has been a major factor in the success of the course. This has been accomplished largely through cooperation between the engineering faculty and the members of the English faculty who teach technical writing and who for all practical purposes are also members of the engineering faculty. Technical writing is recognized throughout the College as an integral part of engineering education. Contrary to the situation found in many schools, the English Department itself has been quite cooperative in recognizing the importance of the technical writing pro-

gram and in granting the necessary aid and support for its success.

The engineers who have had the course, if they are proficient in the other engineering skills, are invariably better prepared to meet the demands of their profession than those who have not done any work in the specialized techniques of engineering writing.

A Description of the Course

The first semester of work in technical writing is devoted to the basic mechanics of writing technical reports. Students are first reminded that "non-technical" words may have precise meanings, and they are instructed again in the proper use of the dictionary. They are taught how to explain a definition to someone in what is called an "extended" definition. Later in the course, they are taught to write an essay on some word to show how the meaning has changed with usage.

Students are taught to write clear, concise, precise exposition on technical subjects. The style may often be uninspired and flat because the engineering student with much literary ability is exceptional; but the style must by all means be lucid. The experience of alumni in industry and of the staff members who have worked in industry has been that the bulk of engineering writing does not involve selling an idea, but merely stating facts. The type of communication which must entice the reader is taught during the second semester. Stress is given to the importance of a neat, mechanically correct paper.

The students learn how to describe a technical process; how to give clear directions; how to describe an apparatus and its functions; how to evaluate technical information objectively in writing; how to make objective comparisons; and how to determine whether or not it would be more effective to make an evaluation through comparison and contrast or through an isolated study. They are taught the techniques and functions of classification and the respective forms and purposes of reviews, summaries and abstracts. They are taught to compare and evaluate opinions, news stories, articles from various magazines and the magazines themselves.

A great deal of emphasis in the first semester, as has already been indicated, is given to evaluation and comparison. It is explained to the students exactly what makes good standards for evaluation and how to set up such standards. They are taught that for the purpose of evaluation, standards must be precise and justifiable. They are instructed in the less obvious methods of measurement by such standards. Since a comparison paper requires a somewhat more sophisticated organization than an evaluation paper, the students are taught to make comparisons after they learn to make evaluations. To be sure, a comparison is a form of evaluation and vice versa. But a comparison as such involves two or more items to be tested against each other. The students are taught to make comparisons on similar bases in order to determine the better or best of a group. In general, the chief emphasis in the first semester of work is on logical thinking demonstrated in writing for a particular reader.

The second semester of work allows the student greater freedom of expression than does the first. It has been found, however, that most engineering students do not appreciate this greater freedom. They simply don't know what to do with it. Consequently, there is constant prodding of the student to write in a language which reflects his own personality, within limits of course, and to avoid the use of stereotyped phrases and clichés. Though the writing is still rather fundamental, it is on a somewhat higher level.

One important part of the work is in writing a formal report on some special project that has practical significance. The student must take an actual problem requiring the gathering of real facts and work out a solution, which is sometimes good enough to be used. In other words, the problems are not contrived for the purpose of the course. Since not all

students have access to laboratory facilities, they are urged to choose a project which requires as little actual laboratory work as possible. Many of them, however, are able to write reports on work which they are doing for courses in their respective fields. Since a student would have to write a report on this work anyway, he is often able to combine assignments and write the same report for both the writing instructor and the other instructor. This cooperation helps the student see firsthand that his ability to write is an aid in his professional work. A further instance of such cooperation is that in each of the several departments in the Engineering College, a student who has demonstrated his ability in technical writing is given the job of grading the quality of the writing in reports submitted in that department.

The first report on the project is a description of the problem and its practical importance. A preliminary report is then written which deals with the various possible methods of studying the problem and presents the method which is most likely to be successful in terms of estimated cost, time and results. The students are shown that if the preliminary report is not done well enough to support the recommendations made in it, the project ends right there. The preliminary report must be detailed enough and convincing enough to warrant the sometimes very large expenditure necessary for a solution to the problem. The persuasive elements of the report, however, are not essentially rhetorical, but factual. Though in industry a preliminary report may be a formal report or only a letter, or even just a verbal report, each student must write a formal preliminary report. The format of this formal report is designed to train the students to handle whatever variations they may encounter in actual practice. If the estimated cost, time and results seem to warrant a further investigation of the problem, this preliminary report is followed by progress reports from time to time until the study is complete and a solution has been found. A final formal report presents this solution.

The students are taught how to write articles for a technical magazine. Those articles which are good enough are considered for publication in the student engineering magazine, *The Transit*. Unless the article is unusually well done the first time, it is revised. Further instruction is given in the composition of summaries, reviews and abstracts. Various types of business letters are written: a letter requesting information; a letter of application; a letter accepting a position; a letter requesting a sales interview, and others.

The students are instructed in oral composition. They learn how to get up before a group and describe a technical process with the use of visual aids. They are taught to give directions, to explain how to do something. They learn how to give a sales talk and a report making recommendations. It must be stressed that this is not a course in public speaking as such. There is a Department of Speech at the University for that purpose. This part of the course is designed primarily to train the students to give effective oral exposition dealing with various types of technical subjects.

During the two semesters of Technical Writing, the students write almost continually; there is a written assignment due almost every class period. The students are impressed with the fact that the only way to learn to write is to write and then write some more. Special attention is given to the overt psychology of writing, to obvious adaptation of style and emphasis for a particular reader. During the second semester, a great deal of attention is given to the art of attracting the reader to articles, letters and talks.

An integral part of the technical writing program is the emphasis on illustrations. I use this term to refer to drawings such as flow sheets and orthographic projections, charts and graphs of various

kinds, tables, diagrams of other kinds and, of course, photographs. The students are taught the diverse functions that illustrations may have, such as to emphasize, to summarize, to clarify, or merely to attract the reader. Since the students are given three semesters of engineering drawing prior to the course in writing, the major emphasis is on how to select the subject matter and form of the illustration so as to supplement the report or article. Drawing is considered as a form of communication in itself, but auxiliary to the writing. An instructor from the Department of Engineering Drawing lectures on supplementary illustration at the beginning of each semester. The drawings are graded by a drawing grader on the basis of appropriateness, completeness and quality. In the second semester, illustrations are considered also from the standpoint of how well they lend themselves to publication. The students are taught, for instance, how to make illustrations that are improved through reduction, rather than impaired.

You may argue that this sounds fine as far as the objectives of the course are concerned, but whether or not these things are actually accomplished is another matter. It is not claimed that the course is one hundred percent effective in teaching these various skills. Neither is it claimed that all of these skills are initially instilled in the student during these two semesters. The students have learned in their previous professional studies how to make analyses and evaluations and how to distinguish between opinion and fact. What they have not yet learned is how to organize and present an analysis or an evaluation to other people. At the risk of being somewhat repetitious, let me say that they have not learned to communicate. By the time they have finished this course, they know how to say what they mean so that those on the receiving end can understand. Naturally some learn how to do this better than others do; but I think it is safe to say that every student leaves the course with a much better knowledge of these skills than he had before.

The Four Neglected Aspects of Report Writing

It is pointed out in "Our Schools Can Teach Writing—If They Are Made To" that colleges fall down in teaching at least four important aspects of technical writing. First mentioned is the neglect of the question: *Who is your reader?* Undoubtedly this is a point far too often overlooked in a basic writing course. At Iowa an effort has been made to remedy this oversight; constant stress is given to the proper "slanting" of material.

There is at least one important implication to this matter of finding out who your reader is. Students in a business writing course were told to write papers to be read by a certain group of factory workers. But having never worked in a factory and having very little knowledge of factory workers, most of the students were quite inept at expressing themselves to such an audience. They had answered the question *Who is your reader?*, but so superficially that real communication could not occur. The students in Technical Writing at the University of Iowa are taught that they must have specific information regarding the knowledge and attitudes of their intended readers. The writer must *know* his reader and know him well. The better the writer knows the reader, the more effective his work will be.

This problem is solved by having the engineering students write their articles, reports and speeches for a student audience. A student is in a position to be well aware of his fellow students' general knowledge and attitudes. In some cases the student is told to address his material to other students in his particular field and at other times to engineering students in general.

The second item neglected in teaching report writing, according to Wilson's article, is the use of tables. It has already been mentioned that in this course heavy emphasis is placed on supplementary illustration. Teaching the use of tables is part of this, though perhaps more empha-

sis should be given to tables. Wilson points out that tables require a rigid format depending on very exact classification. It has been found that many students in engineering have no clear knowledge of the process of classification and its functions. They are taught this in the first semester of work.

The article next mentions illustrations in general. The concern of this course with illustration has been pointed out.

The fourth and last item mentioned is the neglect of methods of reproduction. It is questionable whether or not the teaching of methods of reproduction is really necessary to the extent that is indicated in Wilson's article. It is said, for instance, that a report to be reproduced in ditto need not be "combed over" to the extent that a report coming out in hard type and between hard covers should be combed over. The effectiveness of communication depends to some extent on the method of reproduction, it is true; but the actual writing of the report should not be influenced by this, except perhaps indirectly. All reports should be combed over. The person who is to write the report will know the format to be used and will use it; he will probably know very little about methods of reproduction. And the formats will vary from company to company.

The Future of the Course

The course of study in technical writing at the State University of Iowa has the answers to many of the initial problems facing such a program, yet there is a long way to go. It is not a foregone conclusion at this point that certain basic techniques and certain types of reports are stressed as much as they should be. Perhaps some features of the course will be abandoned as they are proved to be useless. The course is always modified from a pragmatic point of view: What do the students need to know? This question is answered partly by keeping in touch with alumni and their industrial employers.

It is true certainly that the basic principles of writing are universally applicable to all kinds of writing. Perhaps the day is not too far distant when every professional school and college will pay more attention to teaching these basic principles and the adaptations which are peculiar to the needs of their particular students.

Army Needs Help on Ordnance Engineering Handbook

Collections of terminologies, glossaries, specialized dictionaries, etc. concerning ordnance engineering are needed by the Army in preparing a comprehensive Ordnance Engineering Design Handbook to summarize fundamental principles and basic design data. The handbook is being written to provide needed information to army ordnance and arsenal personnel and to the engineering staffs of contractors having ordnance design responsibilities.

Corrosion Instruction in Engineering Colleges

By F. E. ALLEN

Development & Research Division, The International Nickel Co., Inc., New York City

During the past decade industry has been paying increased attention to corrosion prevention with the result that much has been accomplished. The engineering profession is also recognizing the growing need for more fundamental knowledge of metallic corrosion through the Engineering Foundation which is endeavoring to establish a Corrosion Research Council. It is becoming, therefore, increasingly important that engineering students have a knowledge of the fundamentals of corrosion and be aware of the problems created by corrosion.

However, information on the attention given to corrosion principles in engineering schools is not readily available, and to obtain information on the current status of this instruction a questionnaire was sent to 141 accredited engineering schools in the U. S. Replies were received from 122 of these institutions and the results are briefly summarized as follows:

Schools offering specific courses in corrosion	37
Approximate number of students taking courses each year	550
Schools that consider corrosion in at least one course	105
Schools with facilities for corrosion research	74
Schools where corrosion research is in progress	34
Students engaged in corrosion research	91
Graduate elective courses in corrosion offered at 29 schools	
Undergraduate elective courses in corrosion offered at 10 schools	
Graduate course in corrosion required at 1 school (ChE)	
Undergraduate course in corrosion required at 6 schools (PetE, ChE, MetE)	

The fact that about 550 students are enrolled in courses covering corrosion phenomena indicates a growing interest in corrosion and an increased appreciation of the need for knowing something about it in several branches of engineering, principally in chemical engineering and metallurgical engineering. At 18 of the reporting schools, these courses are taught in metallurgical engineering or metallurgy departments, and at 13 schools in chemical engineering.

Several hours per semester are spent on corrosion at 105 of the reporting institutions. This instruction, with but few exceptions, is taught without laboratory and is included in various courses. Of the schools reporting, such instruction is given in 119 metallurgy courses, 31 materials courses, 36 chemistry courses, and in 9 miscellaneous courses.

In addition to academic credit courses, 9 institutions reported having sponsored short courses in corrosion for industrial personnel. These courses last from 2–3 days and are conducted at the school using institutional facilities and staff as well as lecturers and educational aids from industrial sources.

It is gratifying to learn that as much attention as revealed by this survey is being given to corrosion in the nation's engineering schools since such problems ultimately become the concern of the engineer. It is also apparent that much more needs to be done both by industry and our educational institutions, especially when the cost of corrosion to the country is so high. It has been estimated that this amounts to over $5.5 billion a year in the United States.* Since corrosion is all loss, whatever can be avoided becomes a source of gain, either financial or from a conservation of metal resources and associated human and energy resources which are also involved.

* "Cost of Corrosion in the United States," by H. H. Uhlig, *Chem. Eng. News*, 27, 2764 (1949).

Nuclear Engineering and Science Congress

December 12–16, 1955, Public Auditorium, Cleveland, Ohio

Members of ASEE are invited to participate in this Nuclear Engineering and Science Congress. It will be the largest and most important conference of its kind ever held in the United States. It is being coordinated by ENGINEERS JOINT COUNCIL for 26 engineering and scientific groups. All the major U. S. organizations concerned with the atom in engineering, science, industry, and government are cooperating in this joint undertaking.

292 TECHNICAL PAPERS

. . . presented by leading nuclear authorities from 16 universities, 13 government laboratories and bureaus, and 34 major industrial corporations, plus England, Canada, Australia, and South Africa.

GROUPED INTO 50 SESSIONS

. . . running concurrently, covering latest developments in nearly every phase of industry, science, and medicine . . . authoritative information made available after the Geneva Conference papers were selected. An average of 4 societies, government agencies, etc., cooperating in each of these sessions.

A LARGE ATTENDANCE IS ASSURED

. . . from government (A.E.C., its laboratories, and others); finance and insurance; management and technical staffs of the atomic industry; members of ASEE and the 25 other groups participating in this joint event . . . plus representatives of non-nuclear industry looking for ideas to use.

INTERNATIONAL ATOMIC EXPOSITION

. . . sponsored by the American Institute of Chemical Engineers, to be held in conjunction with the Conference, December 10–16, 1955.

. . . the latest nuclear developments from all over the United States and foreign countries.

. . . exhibits by virtually every major supplier and service organization in the nuclear field.

. . . models of all major atomic reactors, including an actual research reactor in operation.

. . . the by-products of atomic power at work—industrial, medical, agricultural, and other devices and materials using isotopes.

. . . entirely new educational exhibits by the A.E.C. and selected universities, including new research developments.

FOR REGISTRATION INFORMATION

. . . Write to: Engineers Joint Council
29 West 39th Street
New York 18, N. Y.

EXPOSITION INFORMATION

. . . For full information about how companies can exhibit at the Atomic Exposition, write to:

International Atomic Exposition
931 Book Building
Detroit 26, Michigan

PRIMARY PURPOSES OF THE CONFERENCE

Thorndike Saville, President of Engineers Joint Council, summed up the primary purposes of the Conference as fol-

lows: "The horizons for the peaceful application of atomic developments are, as yet, not even imagined. This highly interrelated family of developments is, as yet, very much in the 'idea for application' stage. Therefore, it is of enormous importance to present to those interested a panoramic view with detail as a proper measure of current opportunity and the vastness of potential. Progress for the Conference indicates that it will be the largest gathering of engineers and scientists ever held in the United States to discuss nuclear energy. As such it will be a major opportunity for the communication of ideas and developments among the many thousands of persons in industry, business, agriculture and medicine, for whom the technology of the Atom is increasingly important."

The George Westinghouse Award

The George Westinghouse Award is an annual award established in 1946 by the Westinghouse Educational Foundation to recognize and encourage outstanding achievement in the teaching of students of engineering. The Award consists of $1000, and an engraved certificate.

The Award has been established to encourage younger men who have shown, by their past record, evidence of continuing activity as superior teachers. To them the Award may serve not only as a reward but as an incentive for further achievement.

In order to achieve this intent, it is deemed essential to limit the Award to those who have not reached the age of 45 by the date of the annual presentation.

Nominations may be made by any person, organization, or group and are to be submitted before February 1, 1956, to the Chairman of the Committee on Award, Professor R. S. Paffenberger, Chairman, Department of Engineering Drawing, The Ohio State University, Columbus 10, Ohio. Nominations must be made on forms available from either the Chairman of the Committee or from the Secretary of the Society. Nominations should be accompanied by significant evidence supporting statements and claims.

Specialists in Diversification *

By H. A. FOECKE

Assistant Professor of Electrical Engineering, University of Notre Dame

Today is an age of specialization. Engineering teachers, like everyone else in society, are encouraged to be specialists. Certain recent developments in engineering education have made more clear than ever before the need for the recognition of a kind of specialist which might be labeled a "specialist in diversification." In trying to discover the nature and function of the "specialist in diversification" it will be necessary to take a brief look at the system of engineering education as a whole and to describe the characteristics of some of the other specialists who are a part of it.

For purposes of this discussion, an educational system will be considered to be the formal agency which our society has established for the purpose of guiding and inspiring the student in his quest for knowledge, in his journey to a chosen intellectual frontier. That being the case, no matter how far the frontier advances, education in some form will attempt to keep close behind. Formal schooling will end when it is no longer the most expeditious means of speeding the progress of the student to his goal.

Not too many decades ago, engineering education was a relatively simple system. An average undergraduate college student could absorb in his academic career a reasonably large portion of what might have been considered the sum total of engineering knowledge of that day, and he could be brought up to the frontiers of engineering knowledge on a rather wide front. The enrollments were relatively small and the staff correspondingly few. The functions of administrator, counselor, teacher, professional engineer were all to be found to some degree in each staff member. There was little specialization in the sense we know it today. This was equally true in the subject matter areas where there were relatively few special teachers for special subjects. The distance between the beginning and the end of what could be called engineering education was short, relatively speaking.

By contrast, in the system of engineering education today, there are many specialists. Not only are the functions of research, teaching, administration and guidance and counseling more sharply differentiated and concentrated in certain staff members, but in the subject matter areas there are many more special teachers for special subjects than in the early days. The basic reason for this increasing complexity is the ever increasing gap between the beginning and the end of the formal part of engineering education. This gap is increasing as the frontiers of knowledge are steadily and relentlessly pushed back. It is no longer possible in the span of a student's undergraduate years to bring him to a large section of the frontier. The time will come, and indeed may already be here in some curricula, where it will be impossible for the average student to reach the frontier in his undergraduate study, depending upon his particular goals. The important fact is that engineering education, even the formal part of it, will continue to grow. If its function is the aiding of scholars in their search for the frontiers, whether the process takes four years or eight, there will be teachers stationed all along the

* Awarded First Prize in the ASEE Young Engineering Teachers Paper Contest of 1955.

way, from beginning to end, to inspire and guide the student.

Permits Differentiation

While all the teachers in a certain sense have the same function, the manner in which they carry this out is quite different owing to the immense variety of formal courses, scattered as they are across the whole gamut of engineering education. This permits differentiation according to special functions. For instance, there are many teachers who, figuratively speaking, work within shouting distance of the frontier. It is their responsibility to give the students a detailed knowledge of the neighboring front, what technical battles are currently being waged, what large problems remain untouched. They must help the students to equip themselves with the very special skills and techniques needed in order to become skillful technical warriors. To be ideally prepared as a teacher of such courses, each would have to have spent some time at the frontier, to have first hand knowledge of it. While teaching, close contact would still have to be maintained. If the teacher were teaching some form of engineering practice, design work for instance, the teacher in planning and carrying out his professional development as an educator would include such musts as industrial experience, consulting work, and registration as a professional engineer. A teacher whose courses prepared students for specialized research work might follow a slightly different path in striving for professional development as an educator. His program would probably include a doctorate in his specialty and continuing technical research of publishable quality. In both cases above, the whole purpose of their activities would be to equip themselves to be better teachers for the courses in the area of their concentration. Such teachers would need to give very little thought to refinements of teaching techniques because their students, being within sight of their respective goals, would usually be highly self-motivated.

If, as postulated above, certain teachers take specific steps to qualify themselves to be inspiring teachers of their students in the area of their concentration, would it be wise to expect them to leave the area of their concentration and shift mental gears several times a day in teaching freshman or sophomore courses? What is the responsibility of the teachers of students just embarking upon a program of engineering education? At this stage, the students will still have many choices to make, many alternate paths open to them. Their teacher must illuminate the way for some distance ahead, point out in a general way where the various paths lead and do so in a balanced and unbiased manner. The students must be given the chance to make intelligent decisions. Even if the specialists described above relished the opportunity to teach the more basic courses, they would probably find that they would not possess the optimum qualities for such activity.

Can any teacher reasonably be expected to elect this as an area of concentration? What special abilities should teachers of introductory courses have and in what way should they plan their professional development as teachers so as to be of maximum service to engineering education? In short, in what way should they specialize? What follows will be an attempt to justify the statement that the existence of teachers concentrating in these areas is reasonable and perhaps necessary and that these teachers could be described as diversification specialists.

Consider first of all what type of individual would want to confine his teaching activities to introductory and basic courses. It would be a man, and surely there must be many such men, whose major interest in engineering education is in the activity of teaching itself, a teacher who would enjoy teaching almost anything but who enjoys teaching engineering subjects most of all because his mind is interested and challenged by technical concepts and truths. Such a teacher would take pride in his strategic role in launching students upon engineering careers, he would sense the importance of his pivotal

position. He would know that his students are not near enough to their goals to be invigorated by the sound and smell of intellectual battle at the frontier and therefore they are not, on the average, highly self-motivated. This teacher would be more concerned than others with teaching methods, course organization, and pedagogical problems in general. If such a teacher is to guide and inspire students whose individual paths will go in many different directions, if he must illuminate the way for them, he must necessarily have a rather diversified background instead of a very narrow one, consisting of detailed information about one subject matter area. Such a teacher ideally would be a specialist in diversification. In that way he could best fulfill his particular role in engineering education. Just as the other specialized teachers had special ways of developing themselves to be highly successful teachers in their areas, so will the specialist in diversification. He would be doing educational research of a publishable quality in teaching methods, curriculum design and the like. He would be taking advanced fundamental course work in many areas. All this to make him a better teacher in his area. Unfortunately, the real need for men dedicating their lives to these fundamental areas has not been explicitly recognized as much as the need for advanced specialists. Therefore, it may be some time before recognition and advancement will follow as it should. The more traditional methods of development are less applicable in the case of the man who wishes to perfect the basic courses and needs a broad rather than a narrow background. When such specialists in diversification are encouraged, all of engineering education will certainly profit, for is it not true that some of our weakest teaching is done on the lower levels?

Growing Sentiment for Less Specialization

Of special current interest is the Interim Report of the Committee on Evaluation of Engineering Education. The authors of the report stress the growing sentiment for less specialization on the undergraduate level. The committee proposes a curriculum with a common stem and it explains that the term "common stem" does not imply identical courses but is a phrase intended to clarify the need for a "unity of understanding" by students in different curricula. The teachers best equipped to help students to develop this "unity of understanding" would be those who had experienced it. It seems more and more imperative that at the lower undergraduate level we have not highly concentrated specialists but specialists in diversification, men who have developed by crossing traditional departmental lines (sometimes grown to walls) and roamed far and wide, the better to guide students in their progress. Such men would be the living example of unity of understanding. It is conceivable that a limited number of men would form links between colleges of engineering and sciences, or even better, where unity of understanding is even more lacking, between colleges of engineering and liberal arts. A specialist in diversification would be able to speak the technical languages of both camps and act as liaison expert.

A number of articles published in the *Journal of the ASEE* have bearing in some way on the subject of this paper and are quoted below as a means of summarizing. The ASEE Committee on Recognition and Incentives for Good Teaching in a recently published article said: "The committee also recognized that teachers are employed to produce certain specified, desirable results. One of these is introducing students to a subject. Another is carrying them up to the intermediate stage. And still another is carrying them to the frontiers of knowledge in a subject. A teacher who is adept in producing one effect and performing one function with students may be quite ineffective if asked to produce other effects. A wise administration recognizes these differences and uses its teachers where they can be most effective" (1).

Thomas K. Sherwood, former Dean at M.I.T., had this to say regarding specialization in a department: "Though we would look a long time to find a man with all of the qualities on the list, it is not necessary that we find him, for many of the qualifications listed, though essential to the composite staff of a department, are not absolutely essential in each and every staff member" (2).

Regarding the background of the teacher of basis courses, Allen H. Blaisdell said: "In brief, since the bulk of engineering graduates will likely never receive more than four, or five at the most, years of college or university instruction it seems reasonable to suppose that such instruction should be placed in the hands of teachers who are not specialists, but men of general scientific knowledge, broad and sympathetic outlook, as well as sustained interest in the activities of the engineering profession. Possibly one might add that the less instruction the undergraduate student receives from pronounced specialists of any kind, the less unbalanced his basic education. . . . Common sense would seem to indicate that the highly trained and specialized scientist will not, of necessity, achieve spectacular results in his efforts to instruct undergraduates unless he is fortunate enough to lecture in the field of his specialty. When it happens that he is assigned to instructional duties of a more general nature, the specialist is placed at a disadvantage as compared with the teacher possessing broader background and more diversified experience in teaching" (3).

In another section of the Committee on Recognition and Incentives report the following is found: "The one important prerequisite for good teaching appears to be a growing mind. Whether that mind is growing as the result of a search for better teaching methods, for more knowledge, for better methods of applying knowledge, or for various other reasons is apparently not so important as the fact that the mind of the teacher is growing. . . . The question of teaching ability versus knowledge is one that must be solved by each university and each department in its own way. So much has been said upon both sides of this issue that the committee approaches this problem with great reluctance. Certainly no one would hire as a guide in frontier territory a person who had never been there. On the other hand, undergraduate education in engineering and science travels through fairly well explored regions, and many people who have never been to the frontier are completely familiar with these regions. These people serve not only as adequate but frequently as excellent and inspired guides." (1)

Conclusion

In conclusion, if the introductory undergraduate engineering courses are to be taught in the best possible manner, if engineering students are to achieve a "unity of understanding," it would seem that one of the best ways of doing this would be to recognize the need for teachers with diversified backgrounds and general interests, teachers with a great love for the activitiy of teaching itself, dedicated to the important task of launching students upon engineering careers in the best possible way. Such specialists in diversification are sorely needed.

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Professional Development of the Young Engineering Teacher*

By DONALD R. LAMB

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The problem of professional development in the Young Engineering Teacher is by necessity twofold. As was pointed out by the General Council of ASEE, the objectives set forth for the YET group included: "An understanding of the general goals and responsibilities of the two professions which every teacher of engineering follows: engineering and education," and "Guidance in his personal professional development both as an engineer and as a teacher." This bifurcation, however, converges into one single purpose: becoming a professional person.

"Whosoever shall compel thee to go one mile, go with him twain." This portion of the Sermon on the Mount adjures perfection. "Every avocation has its mile of compulsion, its daily drab tasks and duties, its standards of honest craftmanship, its code of man-to-man relations, which one must cover if he is to survive. Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance. It is only in this second mile that a calling may attain to the dignity and the distinction of a profession" ("The Second Mile," William E. Wickenden, *Electrical Engineering,* May 1942). It is this second mile that concerns the YET today. With the excellence of education at the disposal of all, the first mile can be accomplished by most engineering graduates. Before one can start on the second mile a definition of profession as well as its qualities should be set forth. The dictionary conveys the idea that a profession is an occupation which requires a liberal, if not a specialized, education and involves mental rather than manual labor; that a profession implies scholarship as in the case of the learned professions of law, medicine and theology.

Since the three learned professions are generally cited as examples of what a profession is, service to society or ministry to the people is an important characteristic of a profession. A quote from Vannevar Bush on "The Qualities of a Profession" (*Electrical Engineering,* April 1939, pp. 156–160) will help exemplify this point. "In every one of the professional groups will be found the initial central theme intact—they minister to the people. Otherwise they no longer endure as professional groups.

". . . Ministry carries with it the ideas of dignity and authority; it connotes no weakness, and offers no apology. . . . There is no fog of subservience surrounding the concept. The physician who ministers to his client takes charge by right of superior specialized knowledge of a highly personal aspect of the affairs of the individual. The attorney assumes professional responsibility for guiding the legal acts of his client, and speaks with the whole authority of the statutes as a background. It is in this higher sense that we trace the thread of ministry to the people.

"This is the fuel which has kept alight through many ages the professional spirit.

* Awarded Second Prize in the ASEE Young Engineering Teachers Paper Contest of 1955.

Every time that the fuel has become exhausted, the light has gone out. It has not mattered how much was retained of trapping and mysticism nor what the profundity of utterance, there has been no true profession that has not with dignity and authority advised and counselled the people, that has not guarded the commonweal. For a true profession exists only as the people allow it to maintain its prerogatives by reason of confidence in its integrity and belief in its general beneficence."

A profession ministers to the people. Engineers minister to the people by their many contributions to the health, safety and convenience of the public. The engineering ministry is just as real, but it is usually applied in providing goods and services for people in the mass rather than personal service for an individual citizen. It is not surprising that the average citizen is more conscious of the "engineer" in the cab of the locomotive than he is of the engineer who designs the locomotive and the many other parts of a modern railroad system by which the citizen is enabled more quickly to accomplish his errand in comfort and safety.

Professional Development

The second mile, professional development, is accomplished in part by the individual and in part by his associates. The question "What can we do as individuals?" has been asked many times. If he sees a job that needs doing, and if he wants to have it done, and if he is willing to exert himself to help do it, then a person should start with himself and with those most closely associated with him in his own community. Each one should continually prepare himself for greater responsibilities and for greater opportunities. Each one should support work in the broader field of his professional interest by whatever mechanism is at hand or by joining with his fellows in the development of a mechanism appropriate to their local problems. Each one should be active in some local civic organization, thereby demonstrating to the people in other walks of life that engineers are not narrow, anti-social specialists.

A short digression is in order at this point. The first premise discussed was professional development. The discussion following this text has dealt with what a profession is supposed to be and how the professional man develops along these lines. Unless at this point it can be definitely said that the profession exists, the evolution of any other ideas becomes meaningless. The author feels that the engineer has a profession but if he does not work to preserve what has been accomplished and strive to add a stronger unity of purpose toward a singular goal, a union and not a profession will transpire.

The second mile now lies ahead. The signs that direct one onward are education and scholarship, research or consulting, complete cooperation with cohorts, participation in learned engineering groups and association with civic programs and ideals. This is the trail of voluntary effort where one can strive for excellence and invest his work for enduring significance.

Formal training is, of course, the prime requisite for entrance into engineering education. The master's degree should be the minimum effort of any person interested in teaching. If, in obtaining a doctor's degree, a person completely burns himself out, he will not be of value in the teaching field because of the lack of energy and individual excitement. Therefore, one will have to make a sacrifice of an advanced degree if it would impair his teaching effectiveness. The formal education that has been discussed ends usually with a degree, but as in other learned professions, engineering is marked by the continuance of study throughout one's entire career.

Scholarship, of course, is an important facet of education. Scholarship in all things is a very worthy goal. But there has to be a meeting point between scholarship and application. Vetruvius summarized this many years ago when he said

"Architects who have aimed at acquiring manual skill without scholarship have never been able to reach a position of authority to correspond to their pains. While those who relied only upon theories and scholarship were obviously hunting the shadows, not the substance. But those who have a thorough knowledge of both, like men armed at all points, have the sooner attained their object and carried authority with them."

The research and consulting signs are out for all to see. It is almost impossible to conceive of an individual who is exerting his energies in the direction of the second mile not being inquisitive. How any man can really teach science or engineering without acquiring a consuming curiosity about the many things that are unknown is unbelievable. And how one can get a glimpse of the unknown without an equally consuming desire to tell it to others who will carry it on is also a mystery. An inquiring mind must be the chief possession of the YET. And that's the only kind of a mind that can either explore the unknown or stimulate associates.

The aim of research is to advance human understanding. We believe in human understanding for its own sake. We believe humans differ from the beasts largely in their ability and their urge to learn, to know, to comprehend. And what good is understanding? Well, aside from the fact that we are unsatisfied without it, aside from the fact that intellectual achievement possesses beauty and elegance which is good for its own sake, understanding leads to advances in human welfare. It abolishes ignorance and fear. Science and engineering are the chief tools in man's eternal struggle to achieve his highest moral and spiritual ends.

Research for All

Even though the cry "I don't like research" has been heard from each section of the country, there is research for all. Research does not need to be highly technical but can be down-to-earth and uncomplicated. We need to have better design methods, better teaching techniques, and fundamental student-teacher problems examined. There is some beneficial type of research for each person along the second mile.

The consulting work a YET can do during the summer gives him a chance to apply the theories he teaches, with conviction, during the winter. The consulting work also gives him opportunity to view how other people apply the theories that were learned and are now used. One cannot discount the financial gain of this type of mental advancement, but consulting should be used for mental growth rather than financial advance. One cannot stand still, he either advances or he falls behind, and in our fast moving society it is extremely difficult to make up lost ground.

The most difficult portion of the second mile is complete cooperation among associates. "Very many people refer all their problems and perplexities of deportment to the Golden Rule: 'Do unto others as you would that they do unto you.' Generous and high-minded men have thought the question through and find the Golden Rule best suited to their outlooks and temperaments. Others are too busy (or too lazy) to think about the question at all. . . ." This quote was taken from "On Engineering Integrity" (Committee on the Promotion of Ethical Standards, ASEE, *Journal of Engineering Education,* Dec. 1953), and certainly points out that cooperation is a thought process first—action second. By following this lesson as well as the parable of the Good Samaritan, the unimportant things that transpire among men to breed jealousy would pass unnoticed. By helping others in the daily problems of teaching, research and scholarship, better cooperation would be established as well as dissemination of knowledge.

Each branch of engineering has its professional group. In these groups the technical information in each field is sent to each participating member. Active work in the founder societies has its rewards in not only making it possible to

keep up with the rapid advances in the field, but in giving an outlet for the productivity of the members. Association with professional people can transmit professionalism to those who are young and receptive.

All of the YETs should also belong to the one educational society, ASEE, of their profession. Not only are the problems and explanations of his age group reported and discussed, but also the great backlog of information and experiences of the not-so-young teachers. Let it be pointed out here that "belonging to" is not active participation in the professional groups. One can get out only as much as one puts in.

As a person settles down into the life of a community he has to become part of this group. To become part of a community one must participate in the affairs of state. It might be at this point that the real public relations part of the engineering profession should have its beginning. The other learned professions have their members in civil groups upholding civic ideals. In a church building program in a western city where a University was located, the building committee was composed of a cross-section of the parish. However, there was a conspicuous absence of engineers on the list, yet there was available at least one engineer from each of the departments in the engineering school.

If engineers are to prove that they are not narrow, anti-social specialists, they will have to become an important part of the community life and become associated with the civic ideals that are important to the life of their families and friends.

Conclusion

In conclusion, it should be pointed out again that the professional development of the young engineering teacher lies along the "second mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance." To close, the lines of Matthew Arnold are a fitting exemplification of professional development: "Life consists not in getting and holding, but in being and becoming."

Lamme Award

The Committee on Lamme Award is always anxious to get nominations for the Award from the membership of the Society. Any member may place a name in nomination; the selection will be made by the Committee by letter ballot.

The Lamme Award consists of a gold medal and bronze replica bestowed annually upon a distinguished engineering educator for excellence in teaching and contributions to the art of teaching; contributions to research and technical literature; achievements which contribute to the advancement of the profession; and engineering administration. The Lamme Trust Fund was established in memory of Benjamin Garver Lamme. For a brochure describing the Award and a nomination form, please write to the Secretary, Professor W. Leighton Collins, University of Illinois, Urbana, Illinois.

Nominations should be sent to the Chairman of the Committee, Dean F. E. Terman, College of Engineering, Stanford University, Stanford, California by February 1, 1956. Nominations should be accompanied by evidence supporting statement and claims.

James H. McGraw Award for 1955—Presented to Frederick E. Dobbs

The *James H. McGraw Award in Technical Institute Education* is an annual award of $500 for outstanding contributions to this field of education. The award is administered by the Technical Institute Division of ASEE and is sponsored by the McGraw-Hill Book Company, Inc.

Citation

To FREDERICK E. DOBBS, distinguished teacher, educator, and administrator—for his outstanding contributions to technical institute education; for his stimulating leadership in the development of technical institute training facilities; for his administrative skill in guiding the destiny of Wentworth Institute through periods of both peace and war; for the enviable examples of curriculum development, instructional facilities, and sound supervision which have characterized his work in this country and abroad; for his superlative achievements for the Ford Foundation in the development of technical education in Pakistan; for his tireless efforts as the Ford Foundation consultant to the Government of India in the development of the small industries program—this sixth annual James H. McGraw Award in Technical Institute Education is presented.

Shown above are participants in the presentation ceremony at the annual banquet of ASEE at Penn State University. Left to right: Dean Eric A. Walker, recipient of the award Frederick E. Dobbs, Dean N. W. Dougherty, Prof. Maurice R. Graney.

Annual Report of the Engineering College Research Council 1954–55

Prepared by HAROLD K. WORK
Chairman

During the past year, the Engineering College Research Council has continued to work on the various problems facing engineering schools, doing sponsored research. The basic problem has been approached in various ways, which are detailed as follows:

Publications

A new edition of "Review of Current Research and Directory of Member Institutions" has been prepared and will be available early in July. This booklet should be valuable to all of our member institutions, to individual faculty members, and to sponsors who are trying to locate and evaluate institutions for handling their research. The Secretary of the ECRC, Mr. Renato Contini, has been responsible for this publication.

A committee under Eric A. Walker has been working on the preparation of a book on "Creativity in Research." They are using as source material a group of papers presented at various symposia and meetings sponsored by the ECRC. In addition, some special solicited papers may be included. The available material is now being evaluated by a publishing house.

The Committee on Relations with Federal Government Agencies under R. J. Woodrow has prepared a brochure entitled "Sponsored Research Administration." This is an excellent handbook, covering many problems of interest to the research administrator. It will be published and distributed to member institutions. Provision may also be made to make it available to others.

Relations with Federal Government Agencies

The Committee on Relations with Federal Government Agencies under R. J. Woodrow has continued to be one of our most important and active committees. The Committee has considered a variety of subjects and a brief resume of such activities will be given here.

Overhead and direct costs of research conducted for the Government are being studied by the committee. A problem exists, with the Department of Health, Education and Welfare and others, who do not want to cover the full cost of the research. The Committee will continue to press for a single standard of payment for research in which research costs are fully reimbursed above the lines of the Mills formula.

A regulation promulgated and distributed by the Department of Commerce which imposed severe limitations on engineering schools in the performance of their functions in education and research was the subject of considerable concern. Through the activities of the committee the regulations were redefined in such a way that it minimized the objectionable features as far as educational institutions were concerned.

Relations with Industrial Research Agencies

The Committee on Relations with Industrial Research Agencies under S. T. Carpenter continued to maintain relationships with those organizations most concerned with industrial research. These included the Research Committee of Na-

tional Association of Manufacturers and the Industrial Research Institute. An attempt was made to arrange a regional conference with NAM but this did not materialize.

As a part of the annual program, the committee arranged joint sessions with the Graduate Studies Division on subjects of interest to industrial research people as well as engineering research people.

Awards

At each ASEE Annual Meeting a series of awards is given for various educational activities but there is no award specifically aimed at the stimulation and improvement of engineering research. A Committee was set up under the chairmanship of R. J. Martin to determine whether or not such an award was desirable. This was decided in the affirmative and the committee is now trying to define the nature of the award and arrange for its financing. It is planned that such an award will be initiated in 1956.

Basic Research

The Committee on Basic Research, which was originally set up to help the National Science Foundation in its engineering research activities, has been discontinued as its services are no longer needed.

Research Administration

Many of the problems in the administration of sponsored research are not covered by our present committees. For example, the excellent salary analysis recently prepared by Virgil E. Neilly would fall in this category. It was decided, therefore, that a committee was needed on research administration which might study various problems in research, such as (1) Overhead costs, (2) security requirements and (3) extra salary payments for staff members engaged in classified research, etc. R. A. Morgen was appointed chairman of the Committee and selected as his first project, the study of how research personnel, in various research organizations, are handled in the matter of tenure, fringe benefits and so forth. The Committee is also considering a study of standardization of reports.

Program for the National Meeting

The program committee under the chairmanship of R. G. Folsom developed an interesting program. In order to be certain that people interested in both education and research would find something of interest in the program, the general session involved relationships between the two. Three eminent speakers, two of which are engineering school presidents and the third a corporation president, were secured.

Another joint dinner was arranged with the ECAC and Dr. E. W. Engstrom, Vice President of the Radio Corporation of America was the speaker.

Two joint, open sessions were arranged with the Graduate Studies Division. It is felt that the combination of our activities with those of other committees should be encouraged in the interest of converting small competing meetings into better joint meetings.

As is customary, a closed session was held at which the various problems of ECRC members were discussed on a more or less confidential basis.

Four executive committee meetings were held during the course of the year as well as numerous committee meetings.

Nominations

The Nominating Committee under the Chairmanship of Frank W. Dawson presented names to replace the following officers who are retiring:

R. A. Morgen
F. C. Lindvall
G. R. Town

Those nominated by the committee and elected by the ECRC representatives are as follows:

K. F. Wendt
T. J. Killian
H. W. Barlow

Report of the ASEE Committee on Atomic Energy Education

Prepared by PHILIP N. POWERS
Chairman

Purpose of Committee and Earlier Activities

The Committee was established in 1950 under the leadership of Thorndike Saville, President of ASEE at the time. Its purpose was to help engineering colleges to become better informed about the needs for engineers with training in nuclear energy and the availability of teaching materials. Close liaison with the AEC was provided at the outset, and regional subcommittees were formed to arrange for conferences.

Committee Meetings Since Last June

The Committee met in Ann Arbor immediately after the ASEE meeting in Urbana last June and again in Chicago in May. Most of the work has been performed by six different subcommittees.

Preparation of Reactor Engineering Textbook

In May of 1951 the Committee recognized the need for a nuclear engineering textbook and proposed to the Atomic Energy Commission that they arrange for its preparation and publication. The Commission acted favorably on this proposal, and Dr. Samuel Glasstone was engaged to prepare the text. Since then, a subcommittee under the chairmanship of Dean R. C. Ernst has reviewed Dr. Glasstone's work, and the final draft was accepted by the full Committee in May 1955 as meeting the objectives originally set. The Commission has now been informed of this action of the Committee and that we believe the book will be very useful in assisting engineering educators to incorporate nuclear materials into the engineering curriculum. The title is "Principles of Nuclear Reactor Engineering."

Conferences at the Penn State Meeting

Under the chairmanship of Professor Glenn Murphy, a subcommittee organized two conferences for the Penn State meeting. The first was on the objectives of atomic energy education and on the present extent of unclassified research in nuclear engineering.

A second conference was held in cooperation with the Relations with Industry Division. The theme was "Industry and Nuclear Engineering Education," and there were papers on the need for engineers with nuclear training, the role of the colleges, and the role of industry in providing the training.

Survey of Nuclear Engineering Research

Under the leadership of Professor Herbert S. Isbin, a survey has been made on the progress being made by our universities and colleges in furthering nuclear engineering research. The Commitee believes that encouragement should be given to educational institutions to increase their research activities in areas involving nuclear energy problems. It is hoped that the data which have been collected regarding present activities will be helpful to engineering colleges in planning their own programs.

Participation in the Nuclear Engineering and Science Congress at Cleveland

Last fall President Dougherty advised the Chairman of this Committee that he had attended a meeting called by the Engineers Joint Council to consider the pos-

sibility of a joint effort among several engineering societies to organize a Nuclear Engineering and Science Congress. He asked the Chairman of this Committee to serve as his representative in subsequent discussions of this problem. As a result, ASEE is one of the participating societies in the forthcoming Congress to be held in Cleveland this coming December. ASEE is taking responsibility for a half-day conference on nuclear education problems. Professor Cliff Beck of North Carolina State College serves as Chairman of the subcommittee which is making these arrangements. The program which we are planning will involve presentations by several outstanding engineers in the nuclear field on the educational requirements for work in the field.

Objectives and Materials for Atomic Energy Education

At its meeting in June of 1954, the Committee agreed that serious attention should be given to what the Committee could do to help in identifying educational objectives in atomic energy and to help engineering professors find out about unclassified materials which might be helpful to them. As a result, a subcommittee under the chairmanship of Dean George Hawkins wrote to 143 deans of engineering schools and asked them to choose among four different ways in which our Committee might help. The plans which he asked them to consider were:

1. Having an individual who is an authority in the field and who understands the problems of engineering education visit your institution to discuss atomic energy education with interested members of the faculty, and to suggest procedures that might be used.
2. Having a team composed of authorities visit your institution to discuss the problems with interested members of the faculty.
3. Having a report prepared and distributed describing various procedures that could be utilized in incorporating nuclear science into the engineering curricula.
4. Sending representatives of your faculty at your expense to regional conferences devoted to the subject.

He had a very fine response with some interest expressed in all four plans, but with a great majority preferring the third, in which a report would be prepared and made available to engineering faculties.

This response led the Committee to believe that it had been given an assignment which it should take very seriously indeed. The recent upsurgence of industrial interest in atomic energy work and the present unprecedented demand for people with competence in nuclear energy makes it clear that the training of the engineers needed has become a big and urgent task. It seems to us essential that the ASEE do what it can to meet the requests which we received and to serve the engineering colleges through helping them to decide how best to meet these demands at the undergraduate and graduate levels and in extension work. Because of the present urgency, the government is providing specialized nuclear training for engineers and scientists from abroad as well in this country, and it seems obvious that engineering colleges must carry an increasing share of this burden.

A Proposed Study of Educational Requirements

The Committee believes, therefore, that it should be authorized by the Society to make a comprehensive study of educational requirements in this field, and we have prepared a specific proposal for the consideration of the Council. The pattern which we have in mind resembles the study which was performed by the Committee on the Evaluation of Engineering Education. It will be necessary to ask some one member of the Committee to allow his office to be used for putting the materials together and the preparation of reports. Financing would have to be adequate to permit the Committee and necessary subcommittees to get together as required and to permit visits to engineering colleges. The plan was prepared by a subcommittee under the chairmanship of Professor Glenn Murphy, and he has agreed to present our plan to the Council.

Report of the ASEE Committee for Young Engineering Teachers

Prepared by PHILIP WEINBERG
National Chairman CYET, 1954–55

Introduction

This report is intended as a brief summary of the activities of the CYET. Included are a series of recommendations, the most significant being a proposal for establishment of a summer workshop for young engineering teachers.

Committee Activities

This year has seen an interesting growth in the committee's functions. Many sections which were relatively inactive in the past have developed many programs. A few formerly active sections showed a noticeable decline. The interesting feature here was that earlier programs had left a residue which kept institutional activity alive even though sectional coordination was lacking. Much depends on the sectional YET representative and the kind of cooperation he can obtain from institutions and sectional officers.

Typical of the activities this year were seminars, panels and conference meetings. Many of the annual section meetings have contained a session planned by and concerned with the YETs. Other activities ranged from dinner meetings for combined groups of administrators and YETs to the planning and financing of a 3-day conference for all young teachers in a section. On this latter statement, I might mention that the section in the past was quite inactive.

Recommendations

1. Officers for 1955–56

a. Professor John L. Artley—National Chairman, Duke University
b. Professor Thomas Boyle—National Vice-Chairman, University of Michigan
c. Professor Lee Harrisberger—Vice-Chairman for Sub-Sections, North Carolina State University

2. Appointment of Sub-Chairmen

It is the recommendation of the committee that sectional sub-chairmen be elected at sectional meetings by the general membership. The term of office to be left to the section but not to exceed two years. It is suggested that the term of office commence no later than the beginning of the school year following the election. Where this is inconvenient, the prerogative for time of taking office should be left to the section.

Reasons set forth for this recommendation are:

a. Closer cooperation is possible between section officers and YET subchairman
b. Increased status of YET representative
c. Procedure will be more democratic

3. Membership Drive

It is recommended that the CYET be delegated to assist the Society in its membership drive. Since an institutional representative is established, it provides the opportunity of a personal contact.

4. Paper Contest

It is recommended that the paper contest be continued. Notification of the

rules should be sent to all section chairmen and the chairman of CYET, by October 1, 1955, for early publicity. It is suggested that papers submitted be reviewed for possible publication value, and that this be publicized in the announcement of the paper contest. It is further recommended that one member of the national judging committee be a qualified YET.

5. Summer School on Educational Methods

It is recommended that a short term summer school be planned by the educational methods division and CYET to precede the convention on a theme stressing pedagogical matters.

6. Annual Summer Workshop for Young Engineering Teachers

It is recommended that a committee be appointed to study the feasibility of establishing an annual summer workshop for young engineering teachers. This recommendation is consistent with recommendation B, Section VIII of the Report of the Committee on Improvement of Engineering Teaching. There are strong indications that industry will support such a workshop financially. The proposal sent to certain prominent educators and responsible industry leaders was in essence as follows: With the impending shortage of teaching talent, there will be a tendency for the schools to meet their needs by the utilization of less qualified persons. I would propose the establishment of a summer school to be held annually for which, say 50, engineering teachers would be invited to participate. Educational theory and methods of teaching specific technical subject matter should be major factors of the curriculum. The only stipulation would be that each teacher take back to his institution the ideas that he had obtained by conducting regularly scheduled seminars and organized programs in which the exposition of the acquired knowledge could occur. Ideally, the staff of such a school would consist of those educational and industrial representatives who have gained well-established reputations and would be well qualified to make a contribution to the instructional facility.

Now as to the details of such a proposal, the mechanism might be an eight-week seminar session to be financed by educational institutions and industry. In very recent years, as you well know, there has been a renaissance with regard to industry's attitude toward education. Industry is now earnestly seeking ways to put education on a firm footing. I suggest that one contribution might be the proposal stated earlier. In a period of ten years (when the shortage of teachers might be severest) 500 teachers with this summer session experience would have diffused through the engineering schools to help maintain qualities of education which may decrease at an alarming rate as the staff shortage becomes pronounced.

The session might be held at the host ASEE institution following the National Meeting thus permitting these young people to participate in the meeting. Each invited teacher would receive a fellowship to compensate for lost income. While many people should be willing to receive the educational benefit without financial compensation, I believe it would be necessary to provide a stipend if qualified people are to be attracted.

To establish a talking point, suppose we consider the following pattern: (1) Host institution or camp site might provide housing and eating facilities at a nominal rate; (2) The institution sending the young teacher would provide the travel funds and in return receive the benefits of an organized seminar program; (3) Industry would provide funds for the stipend and expenses for maintaining the school. This might be accomplished by soliciting a grant from the approximately 100 major companies which have ASEE membership, or perhaps a single organization might underwrite the operation.

What are the advantages that may accrue from such a program? (1) It would tend to provide better teaching and, consequently, provide a better product for industry; (2) In ten years a diffusion of informed young people could only have a stimulating effect on engineering education; (3) It would bring to the institutions ideas that its own faculties may not have explored (through seminars and organized programs); (4) It would permit young teachers to exchange ideas among themselves. This would broaden the base of engineering education by the transfusion of such ideas.

I suggest the committee be composed of engineering administrators, industrial representatives, YETs, representatives from the graduate study and the educational methods division.

Specific items of cost have not been included in this report. However, it is estimated that $60,000 would be required to operate the school and provide fellowships. Mention has not been made of possible solicitation from Foundations. A committee appointed to study the complete problem can best determine the method of securing the financial support. Again, I would like to emphasize that a prepared proposal is very likely to receive favorable support from industry.

These recommendations were thoroughly discussed at two meetings of the CYET in which a past president and a number of deans gave enthusiastic approval.

We have an opportunity to pioneer in an area that has been sorely neglected, that of developing college teachers. Let us give this our earnest consideration.

James H. McGraw Award

The James H. McGraw Award in Technical Institute Education is an annual award of $500 for outstanding contributions to this field of education. The award is administered by the Technical Institute Division of the ASEE and is sponsored by the McGraw-Hill Book Company, Inc. The award is made at the annual banquet of the Technical Institute Division of the ASEE.

Nominations for the award should be sent to the Chairman of the Technical Institute Division, Karl O. Werwath, President, Milwaukee School of Engineering, Milwaukee, Wisconsin.

Candid Comments

It Won't Be Easy

By DAVE SAUNDERS
Consulting Editor

The ability to write so as to convey successfully information of any kind necessarily is based on a comprehensive knowledge of language. Technical writers and editors cannot be made simply by establishing a college curriculum designed to teach technical writing and editing, nor can they be made by teaching English at any level above high school.

An adequately comprehensive knowledge of language begins in the crib. The failure of parents and of teachers in the early school years to teach English renders ineffective any later program designed to produce technical writers and editors. This failure is part of a vicious circle which begins with the fact that today's parents and teachers are generally inarticulate.

It is entirely probable that colleges have not established curricula for technical editing and writing because of the poor material that sits in their classrooms. Students today approach higher learning with only a meager knowledge of English. This is a result of the fact that schools have abandoned the basic theory that all learning depends on language.

"Language" involves much more than the ability merely to read and write. It involves the ability to select the right words and put them together so that the meaning is clear and unmistakable.

Without adequate training in the use of language, no student can be taught to produce good technical writing or to be a good technical editor. Students at lower levels are not being taught how to read and write effectively. When they reach the college level, they have not learned how to express their thoughts or to understand the thoughts of others, most of whom are in the same boat on an intellectually barren sea.

Why have our schools abandoned the basic theory that all learning is ineffectual without an understanding of language? This abandonment is the inevitable result of the unrealistic theories on which is based the so-called "child centered" school. We now are paying the penalty for failure to recognize and insist upon the importance of teaching English first. By "teaching English" I mean really teaching it, not presenting the child with disconnected words which he is not able to assemble properly.

Ours is a literate nation, but it is not articulate. It is an age of cartoon booklets and mystery stories written by authors whose attacks on the English language bring on spine-chilling shudders far worse than those caused by the plots. These authors, remember, are products of the same schools from which it fondly is hoped that the demand for technical writers and editors can be met.

It has been suggested that the discipline of learning to write is too much to expect of our children. Why? When is a better time to learn to write than in the formative years? It is preposterous and insulting to suggest that our children today are of such low mental capacity that they must be coddled.

It has been suggested also that we can't expect grade or high school students to be saddled with homework. Why not?

The theory that homework is too much for the child is part of the idiotic theories of the child centered school. Nobody ever learned anything beyond the bare essentials by limiting his education to the hours spent in a classroom. Homework is the practice of what is learned in school. The practice that is so necessary to development of a skill cannot be done at the same time the fundamentals are being learned.

These suggestions came from individuals who have not learned that it is grammatically incorrect to follow the adjective "like" with a verb or to start a sentence with a conjunction. Of course, grammar alone is not enough to make a writer or editor. Without good grammar, however, language becomes sloppy; and sloppy writing hardly is the sort of writing on which the culture of our people should be recorded.

With an adequate background in the English language, the man who reaches college level will need no more than a suggestive course in technical writing and editing. This course would need to include instruction in the techniques of reproduction, photography, drawing, and other things pertinent to editorial work.

Colleges have not established adequate curricula in technical writing and editing, not because they consider these subjects unimportant, but because it is impossible to teach them to students whose knowledge of English is pitifully inadequate. You cannot teach these subjects to unprepared students any more than you can teach calculus to a man who has not had algebra.

It would be useless to try to teach technical writing and editing at college level until the lower schools begin to teach English. Students in the lower schools are not required to write enough nor to read enough. Practice in writing should be had at these levels so that when the student reaches college, he can devote his time to college work without having to learn the rudiments of his native tongue. College is not the place to teach basic English, but the place to adapt what the student already should have learned to his college and professional life.

Until something is done about the pitiful condition of English students in schools below college level, we are faced with a continuing shortage of technical writers and editors. In an age when we are confronted with gibberish from the radio, television, press, and publishing house, it is almost a forlorn hope to ask for a Renaissance. There is no indication of it on the intellectual horizon.

Vital Problems

By GREGORY M. DEXTER
Scarsdale, N. Y.

Having retired professionally as a consulting engineer, I am free to argue for a more vital program by the JOURNAL OF ENGINEERING EDUCATION. Too often an article in the JOURNAL impresses me as limited in application or hackneyed as compared with the problems that should be discussed. So here are some vital problems that merit discussion:

1. If progress is to be made in engineering education, freedom of discussion on debatable subjects must be granted. Where strong disagreement on a subject's treatment might arise, arrangements could be made to publish a reply simultaneously with the inciting paper. This method is preferable to arbitrary censorship. In any case, brief discussion later should be invited. If the paper is too long, publication of a condensed version should be offered.

2. A few technical schools and at least one large manufacturing company are

testing prospective engineers for vocational preferences, mentality, and personality to learn if they are fitted for engineering and if so what type. A list of schools doing so, cost, and results obtained would be a valuable paper for future engineers.

3. The United States for industrial as well as defensive reasons needs all the engineers it can get. Artificial barriers should not be allowed to handicap Jews and Negroes from getting the necessary education as engineers. To what extent have the barriers been eliminated? Special effort was needed in New York State and is presumably needed elsewhere.

4. Some of our state technical schools are obliged by law to take all applicants who graduate from high school, regardless of their capabilities. What is the mortality of the freshmen in those schools compared with schools with stiffer standards? How do results compare with schools using the College Board Tests where the score is 500?, 600?

5. The Society should carry in its journal protests of any censorship of teaching as it occurs. There have been several deplorable incidents in the last few years. The most recent was the barring by the University of Washington of an address by Dr. J. Robert Oppenheimer, certainly one of the leading world physicists. Are our future engineers to be educated only on pap or are they to be given the opportunity to hear the best the world has to offer?

The list above could be easily increased. It should serve however to show how the JOURNAL could be handled to serve a more vital function in engineering education.

Evaluation of Engineering Teaching Ability

By FRANCIS W. ROYS

Dean of Engineering, Worcester Polytechnic Institute, Worcester, Mass.

In the May 1955 issue of the JOURNAL OF ENGINEERING EDUCATION is an article entitled "Evaluation of Engineering Teaching Ability" and at the end of the article is an editorial remark saying "Comments on the subject are invited."

It is clear that the writer of the article has done enough thinking to convince himself of the futility of any specific scheme of evaluation by points, items, etc. and as the last two paragraphs plainly testify and I can sympathize with these conclusions for I have tried various schemes, plans, graphs, tables, etc. and always with the same unsatisfactory results.

The answer seems inevitable that the measure of success is in terms of the results. In other words, are the students, on the average able to demonstrate their proficiency in mastery of the purpose of the course when it is completed? If the answer is yes, then the teaching must be evaluated as successful.

But what about the purpose of the teaching? Is it training in skills or intellectual development? Is it indoctrination or education? A teacher may be excellent in one area and very poor in another.

How many teachers, so called, especially the more inexperienced, really stop to think just what they are trying to accomplish? It may be that mastery of a subject may depend mostly on pure memory, like learning the multiplication tables after the idea of successive addition is understood. It may be partly memory and partly association, accompanied in the higher realms by philosophical reflection as in History of various kinds. It may be memory of basic processes followed by logical analysis as in various kinds of mathematics. It may be appreciation and understanding of basic laws of natural sciences, or it may be philosophical generalizations based on

these laws or techniques in their use for the solution of practical problems.

It may be for training in craftmanship in any one of a thousand kinds.

Now, if the purpose of the effort is just to teach someone *how to do* certain things then a method of indoctrination is quite effective and fast but if understanding of why things are as they are and to what purpose or conditions they apply to, or what possibilities and limitations are involved then mental processes of consideration, comparison, analysis, deduction, conclusion, etc., etc. must be developed or *drawn out* and it requires special skills in *educational methods* possessed in high degree by relatively few so called engineering educators.

A man may know his subject; may be an excellent lecturer; may be a fine demonstrator and explainer and so do quite well on an indoctrination basis and yet an almost total failure in accomplishing development of a student's intellectual power in logical deductive analytical and philosophical thinking. In fact, he may be a very poor educator in the real sense of the word.

And so I repeat that if the students have grown under the teacher in real intellectual stature so that on the average they are able to demonstrate their proficiency in mastery of the real purpose of the course at its completion the teacher could well be evaluated as effective and successful.

Any teacher who is able to accomplish the real purpose of a course would, by necessity, have to keep himself up to date by activity in a fair proportion of the areas and interests discussed in Mr. Evans' article.

Good teachers become recognized by their students without any doubt although the attributes of one may be very different than those of another. In fact it is this variety which lends spice to an adequate and effective faculty and it probably is better that we shall be reasonably content with this recognition rather than with any precise evaluation of ability in Engineering Education.

In the News

Dr. J. Whitney Bunting, former president of Oglethorpe University, has joined the Educational Relations Services Department of the **General Electric Company** at New York City as consultant in educational research.

Minutes of the Executive Board

Pennsylvania State University
June 20 and 22, 1955

A meeting of the Executive Board of the American Society for Engineering Education was held at the Hetzel Union Building on June 20 and at the Nittany Lion Inn on June 20 and 22, 1955. Those present were N. W. Dougherty, *President;* W. L. Everitt, B. R. Teare, Jr., L. J. Lassalle, and H. K. Work, *Vice Presidents;* G. W. Farnham, *Treasurer;* W. Leighton Collins, *Secretary,* C. E. Watson, *Assistant Secretary and Editor;* Mrs. Naomi Garman, *Office Secretary;* E. S. Burdell, L. E. Grinter, J. F. D. Smith, *Guests.*

1. *Report of the Secretary*

The mimeographed report presented is attached as Appendix A.*

a. The Executive Board *VOTED* to continue Professor C. E. Watson as Editor until October 1, 1955.

b. Due to there being over 900 members delinquent in dues for one or more years it was agreed a letter from the Treasurer stressing the need for individual dues payment should accompany the next dues statement to these members.

c. The general status of the Society's activity in regard to the Nuclear Engineering and Science Congress to be held at Cleveland, Ohio on December 12–16 was briefly discussed.

d. The Executive Board *VOTED* to increase the salaries of Mrs. Naomi Garman and Mrs. Louise Chambliss $10 per month.

2. *Report of the Treasurer*

The mimeographed pro forma statement for the current year and the budget for next year is attached as Appendix B.

a. The *pro forma* statement replaces what was previously called the "preliminary audit." Outstanding bills or balances were not verified by the auditor in order to avoid duplication of effort and unnecessary expense. The cost of the furniture purchased was charged to current expenses instead of to reserve, as previously directed by the Executive Board, because current income adequately exceeded expenditures. The Executive Board approved both changes.

b. A proposed budget for 1955–56, last column of Appendix B, was submitted for discussion. It was requested that ECAC and ECRC study the amounts allocated and recommend desirable changes. It was understood this budget would need to be modified in accordance with the actions taken at current Executive Board and General Council meetings.

c. The Chairmen of ECAC and ECRC later reported that the proposed budgets for their activities were satisfactory, it being understood that income from the sale of ECRC publications be credited to their account. The Executive Board recommended approval of the budget to the General Council.

d. The Executive Board *VOTED* authorization to the Secretary for the purchase of window air conditioners for the Society's offices and a rug for the Secretary's office.

e. It was agreed to recommend to the General Council that members joining the Society after the first of each year have their membership and dues start at the beginning of the next fiscal year, but that they be placed on the mailing list as soon as dues are paid and informed that they can attend the Annual Meeting.

* Appendices are not presented here since most of them will be printed separately as reports of officers or committees.

3. *Report on ECAC Activities*

The mimeographed report presented is attached as Appendix C.

a. Vice President Everitt explained the progress of the work of ECAC in developing a plan for administering industrial fellowships. It was agreed the proposed method of administration and the acceptance of the check from the first sponsor be recommended to the General Council for approval.

4. *Report on ECRC Activities*

The mimeographed report presented is attached as Appendix D.

a. Vice President H. K. Work explained the desire of ECRC to solicit funds from the National Science Foundation to determine the research needs of the Engineering Sciences and how the needs shall be met. It is estimated that about $40,000 is needed for the two-year study. Engineers Joint Council indicated they will approve and actively support the study and later review the findings. The Committee in charge of the study is to be E. A. Walker, Ralph Morgen, and E. B. Stavely. The Executive Board *VOTED* to recommend favorable action to the General Council. A budget is to accompany the request to the Council. It was suggested a set of rules to be prepared to guide all new chairmen in procedures to follow in the solicitation of funds for ASEE projects.

b. The Executive Board Voted to authorize ECRC to raise $5000 for the establishment of an annual award for research, the award to be a medal. The first award is to be made in 1956, and if no fund has been established by then current ECRC funds will be used. If the award is to bear the name of some individual or company, approval of the Executive Board must be obtained.

5. *Report on General and Regional Activities*

The mimeographed report presented is attached as Appendix E.

6. *Report on Institutional Division Activities*

The mimeographed report presented is attached as Appendix F.

7. *Evaluation of Engineering Education*

a. Dean L. E. Grinter, Chairman of the Committee, read the letter to accompany submission of the final report on Evaluation of Engineering Education to the General Council. The Executive Board approved and commended Dean Grinter and his committee for their excellent work.

b. Funds on hand are adequate for printing needed copies of the report. It was agreed the selling price of reprints should be nominal, essentially the same as for the Interim Report.

c. Money remaining in the fund is not ear-marked and could be used to foster further contacts with industry. The Relations With Industry Division appropriately may wish to sponsor one or more meetings with representatives from industry to discuss the report.

8. *Humanistic-Social Research Project*

a. Dr. E. S. Burdell, Chairman of the Committee, reported that progress was much greater than expected. A tentative report is to be presented at the Tuesday General Session and the final report should be available for printing by midwinter. When the report is completed, it will be reviewed for comments by liberal arts and industrial advisors. It was estimated that about $9000 remained in the fund, sufficient for printing the report. It was agreed the final report should be published in the JOURNAL OF ENGINEERING EDUCATION in order that it be incorporated in the official records of the Society. It was further agreed the style of reprints available for sale need not be the same as the report on Evaluation of Engineering Education. The cost of reprints is to be determined later, but it was agreed it should be low to encourage both single and large lot purchases. Of particular importance was the enthusiastic reception

of the field workers and the "missionary work" they were able to perform.

Note: Item 28C was presented at this session but is reported under "Other Business."

Wednesday, June 22, 1955, 6:30 P.M.

In addition to all the officers listed for the meeting on June 20, M. M. Boring, W. T. Alexander, and F. C. Lindvall, *newly elected officers* were present.

9. *Graduate Study Project*

a. The status of the project was reviewed by President Dougherty. It was agreed the project should be financed by a single grant from a foundation rather than by requests to many industries and other organizations. President Dougherty is to convey this information to Professors N. A. Hall and E. Weber and discuss the project with them.

10. *Educational Aids*

The Secretary was requested to review past correspondence and minutes to determine the correctness of placing the income from the sale of Educational Aids in the general fund of the Society.

11. *Annual Meeting Guide*

Professor John C. Reed reported by letter that in accordance with instructions from the Secretary he had completed the preparation of the Guide and was submitting 100 mimeographed copies with the recommendation that they be used. The report was accepted and the Executive Board *VOTED* to give Professor Reed $25 with which to purchase a gift for his secretary. It was agreed not to make further changes or additions until the local committees at Iowa State and Cornell and Professor K. L. Holderman had the opportunity to use and review the guide.

12. *Summer Institute Program*

a. Plans for the Summer Institute on Theoretical Engineering were deferred pending conferences with representatives of the National Science Foundation.

13. *Lamme Committee*

The report was accepted and submitted to the retiring president for consideration in appointing new members of the committee.

14. *Summer Schools for 1956*

It was recommended the requests be submitted to the General Council for approval.

15. *Summer School for YETs*

President Boring presented a proposal that each year the host institution of the Annual Meeting sponsor a six-week summer school for about 50 selected YETs. The general objective of the program would be good teaching and the development of good teachers. Each YET attending would receive $600–800 and his institution would pay the necessary travel expenses. The estimated $50,000 required to operate each summer school would be raised from industry.

16. *Book of Collected Papers on Engineering Education*

It was agreed the preparation of such a book was not within the scope of the work of the Society.

17. *San Francisco International Science Center*

It was agreed no information would be submitted until more information became available.

18. *Evaluation of Dutch Engineering Education*

It was agreed the matter should be referred to EUSEC, and President Boring will reply.

19. *AAAS Meeting in Atlanta*

No action was taken on the proposal to hold the meeting elsewhere.

20. *AAAS Science Teaching Emergency*

The program was announced for information only.

21. *ASEE Editorial Committee*

It was agreed no appointments should be made until after the new Editor is appointed.

22. *Committee on Society Functions*

a. Dean B. R. Teare, Jr., Chairman of the Committee presented some of the proposals being considered for improving the Society organization and functioning. The Executive Board *VOTED* to allocate $800 to $1000 to the Committee for holding a two-day meeting to complete their study and prepare a report.

b. It was agreed to recommend to the General Council that the name of the Upper New York Section be changed to the Upper New York-Ontario Section, provided a written request from Toronto University (and/or) Queens University is received.

23. *Printing Costs*

George W. Farnham, Chairman of the Committee, reported that lithographing the YEARBOOK would result in no economy the first year and some thereafter but not enough to warrant a change at this time. The study of the cost of printing the JOURNAL in the South is underway. It was agreed the study should continue and results presented at a later meeting.

24. *Institutional Membership*

a. Associate—The Executive Board elected Frederick Post and Company to Associate Institutional Membership.

b. Active—The Executive Board elected Ohio Northern University to Active Institutional Membership, subject to election by ECAC and ECRC to participate in their activities.

25. *Bank Resolutions*

Not presented.

26. *Future Annual Meetings*

The locations and dates for the next two years were reviewed. They are as follows:

Iowa State College....June 25–29, 1956
L. O. Stewart, General Chairman
Cornell University....June 17–21, 1957
J. C. Gebhard, General Chairman

27. *Next Meeting of Executive Board*

It was agreed the next meeting of the Executive Board would be at the new headquarters of the Society, University of Illinois, Urbana, Illinois, September 10, 1955.

28. *Other Business*

a. It was agreed the report on Degree Designations be presented to the General Council.

b. The Executive Board *VOTED* that the President appoint two members to serve on a joint EJC–ASEE–ECPD committee to plan the annual meeting of the Engineers Joint Council. It is to be held in late January of 1956 and the theme is to be Technical Institutes. The Society assumes no financial obligation.

c. The Executive Board *VOTED* to grant Dean W. L. Everitt, Secretary W. Leighton Collins, and President M. M. Boring authority to employ an Editor for the JOURNAL OF ENGINEERING EDUCATION.

d. W. Leighton Collins was reappointed Secretary for the year 1955–56.

e. Dean J. F. D. Smith, Chairman of the Relations With Industry Division, presented the request received for immediate action relative to RWI and ASEE participation in the IAESTE program for bringing students from Western Europe to this country to work in industry for short periods of time. The degree of enthusiasm for the project varies greatly. It was agreed Dean Smith should confer with Dean F. M. Dawson to determine the extent of the work of the International Relations Committee of ECAC and to confer with the ECAC Executive Board.

Respectfully submitted,
W. LEIGHTON COLLINS,
Secretary

Minutes of the General Council Meeting

Pennsylvania State University
June 20 and 24, 1955

A meeting of the General Council of the American Society for Engineering Education was held in the Parrot Room of the Nittany Lion Inn on June 20 and 24, 1955. Those present on June 20 were:

E. E. Ambrosius
H. H. Armsby
George F. Branigan
G. P. Brewington
C. A. Brown
F. L. Carnahan
W. L. Collins
Glen N. Cox
H. O. Croft
N. W. Dougherty
M. A. Durland
W. L. Everitt
George Farnham
Harold Flinsch
L. E. Grinter
F. Groseclose
Henry Hartig
S. C. Hollister
Howard K. Justice
Frank Kerekes
L. J. Lassalle
G. B. Lobingier
George A. Marston
Glenn Murphy
Bert H. Norem
Ralph Paffenbarger
H. P. Rodes
Thorndike Saville
Rex Schoonover
John W. Shirley
P. E. Soneson
E. B. Stavely
L. E. Stout
B. R. Teare, Jr.
N. D. Thomas
Robert Van Houten
R. E. Vivian
E. R. Wilcox
W. R. Woolrich
H. K. Work

Those present on June 24 were:

Alexander, W. T.
Ambrosius, E. E.
Armsby, Henry H.
Dougherty, N. W.
Borg, Grant H.
Boring, M. M.
Branigan, Geo. F.
Brewington, G. P.
Brown, C. A.
Collins, W. L.
Christensen, N. A.
Donovan, E. T.
Dougherty, N. W.
Durland, M. A.
Everitt, W. L.
Farnham, G. W.
Flinsch, Harold
Frush, C. O.
Grinter, L. E.
Groseclose, F.
Hellwarth, A. R.
Jackson, J. L.
Jones, C. S.
Kerekes, Frank
Lassalle, Leo Jos.
Marston, G. A.
Morgen, R. A.
Murphy, Glenn
McNair, Arthur J.
Paffenbarger, Ralph S.
Parker, N. A.
Peery, David J.
Richardson, L. A.
Rodes, H. P.
Saville, Thorndike

Schaffner, C. E.
Schoonover, Rex
Seeger, R. J.
Shackleton, S. Paul
Shirley, John W.
Stavely, E. B.
Stillman, Donald G.
Stout, L. E.
Teare, B. R., Jr.
Thomas, Neil D.
Van Houten, R. W.
Vivian, R. E.
Wilcox, E. R.
Wohlford, J. G.
Work, H. K.
Weinberg, Philip

1. *Report of the Secretary*

A copy of the report submitted to the Executive Board and made a part of its minutes of June 20 and 22, 1955 was distributed to all present.

a. The moving of the Society office to the University of Illinois and the arrangements with the University of Illinois were briefly presented.

b. In accordance with Yearbook figures for 1954 and 1955, Individual Memberships have increased from 7095 to 7560. Of the 7560, 917 have not paid dues for the current year despite receiving three dues notices. During the year 250 members resigned and 42 died. Institutional Memberships were not actively pushed during the year, but according to the Yearbook the number increased from 96 to 112; two organizations dropped their membership during the year.

c. The Council *VOTED* to approve the 54 applicants for individual membership on List No. 1, attached as Appendix A.*

d. The Council *VOTED* to grant life membership to 16 members of the Society who met all the constitutional requirements for life membership. The names are on page 5 of Appendix B.

e. The Council *VOTED* to drop from membership 99 members owing more than two years dues. The list is attached as Appendix B.

2. *Report of the Treasurer*

A copy of the report submitted to the Executive Board and made a part of its minutes of June 20 and 22, 1955 was distributed to all present.

a. Treasurer G. W. Farnham submitted the pro forma statement instead of the previously used preliminary audit and explained the reasons for the change. The Council *VOTED* to approve the change and have just one audit made at the end of the year by an established firm of accountants. The audit will be published in the Journal. The *pro forma* statement is included in the minutes of the Executive Board Meeting for June 20 and 22, 1955. It was further suggested that consideration be given to the separation of project funds from Society funds so that the audit indicates the true condition of the Society finances.

b. A budget for 1955–56 was submitted for approval. There were no significant departures from last year other than the addition of items necessitated by moving the Society offices to the University of Illinois. It was understood that the proposed budget did not include expenditures approved during the current meetings. The Council *VOTED* to approve the budget. The proposed budget for 1955–56, the budget for 1954–55, and the *pro forma* income and expense statement are attached as Appendix C.

3. *Evaluation of Engineering Education*

a. Dean L. E. Grinter, Chairman of the Committee, read a letter submitting the final report to the Council for approval and requesting the discharge of the Committee. He also recommended that (1) Any reasonable number of the reports be purchased for distribution to industry and (2) Any funds left over be made available to the Relations With Industry Division for holding one or more conferences between educators and industrial representatives to acquaint everyone with

* Appendices are not presented here since most of them will be printed separately as reports of officers or committees.

the objectives of the report; members of the Committee would be available for participation in the discussions.

The Council *VOTED* to accept the report and that in conjunction with the acceptance, the Society expresses to the Chairman, L. E. Grinter, and to the Secretary, D. H. Pletta, and to the other members of the Committee its gratitude and appreciation for the patience, good judgment and enormous amount of work done in carrying to completion a most difficult assignment.

The Council *VOTED* that the Executive Board be empowered to use the balance in the fund (approximately $5000) to further the aims of the report, particularly as they pertain to the two recommendations made by the Chairman.

b. The opinion was expressed that reprints of the report be sold at a nominal price with a considerable reduction for large quantity orders, just as was done with the Interim Report.

4. *Humanistic-Social Research Project*

a. Dr. E. S. Burdell, Chairman of the Committee, and Dr. G. A. Gullette, Director of the Project, reported that the work had progressed so rapidly that a preliminary report was to be presented at the Tuesday General Session.

b. The final report will be available by midwinter. It was requested that after the report is published members of the committee be authorized to attend Section meetings to discuss the report and in that way spend the remaining funds credited to the project. The request was not granted; instead, the committee was asked to report at the October meeting of the Council and present plans for the publication of the report and for the visits to Sections.

5. *Educational Aids*

a. In accordance with the recommendations of C. W. Muhlenbruch, contained in a letter to the Secretary, the Council *VOTED* to discharge the Committee, but agreed to appoint a new one when demand and interest indicated a revision or a need for expansion into other fields of engineering. The Council commends Mr. Muhlenbruch for the great amount of time he devoted to the project and thanks him, and those on the Committee, for their fine work.

b. The balance of approximately $2000 in the fund is to be held intact for future use of a similar nature and for reprinting the current booklet. It was agreed the Executive Board should study the basis for the contributions from industry to determine the correctness of placing the income from the sales of the booklet into the general fund of the Society, as is done with income from the sale of all other publications.

6. *Graduate Study Project*

a. N. A. Christensen, Chairman of the Committee, submitted a written report, a copy of which is attached hereto as Appendix D. The activities of the Committee at the Annual Meeting and its future plans were outlined. President Dougherty also reviewed the past relations with the Executive Board. Proposals for financing, and the duplication of effort with ECAC's program for Industrial Fellowships were discussed. It was agreed the Graduate Study Division invite the ECAC committee to join it in the study of their mutual problem.

b. The estimated cost of the project is $15,000. The fund is to be expended for travel to two meetings each year and for printing of the report. Five subcommittees are to study the five specific topics. A detailed budget was not submitted, but was requested. The Council approved the study in principle and *VOTED* to refer the entire matter to the Executive Board with power to act.

7. *Summer Institute Program*

a. The Secretary reported that plans were progressing for the publication of the reports for all Summer Institutes sponsored jointly by NSF and ASEE. The reports of the closed conferences on

Mechanics, Electricity and Magnetism, and Thermodynamics have been published in the JOURNAL OF ENGINEERING EDUCATION. It must be recognized that all these institutes were jointly sponsored by NSF and ASEE and that NSF financed all of the closed conferences.

b. The conferences on Theoretical Engineering were not discussed at a General Session because of the need for additional joint planning with NSF.

8. *Resolutions to Officers, Divisions, Committees, and Schools Responsible for ASEE Summer Schools and Conferences*

The Council *VOTED* that the Secretary write a letter of appreciation to the officers of the divisions and committees and schools responsible for the 1955 Summer Schools and Conference.

9. *Report of ECAC Activities*

Copies of the report submitted to the Executive Board and made a part of its minutes of June 20 and 22, 1955 were distributed to all present.

Dean W. L. Everitt, Vice President and Chairman of ECAC, presented the plans developed for administering the three industrial fellowships offered by Leeds and Northrup, one each in Electrical, Mechanical, and Chemical Engineering. The plan proposed for a trial operation was for the Committee to select schools offering the Ph.D. degree and send each a letter asking if they would be interested in having a fellowship. The committee would then determine, by "scientific selection by random number" which school would receive the fellowship. In this way the concentration of fellowships at a few large institutions would be avoided. The Council was requested to authorize ECAC to (a) Accept $3000 from Leeds and Northrup for an initial award for 1956, $6000 for two fellowships in 1957, and $9000 for three in 1958; and (b) Select schools the students could attend and to select from among them, by random number, the school to receive the grant.

In the lengthy discussion which followed, it was brought out that last year's Executive Board authorized Dean Everitt to proceed with the negotiations and develop a plan. The plan was developed and presented to the Council in detail. Doubt was expressed about this being an appropriate area of endeavor for ASEE; constitutional and legal aspects to the question were raised: The Council *VOTED* that the President appoint an ad hoc committee to make a further study of the problem and present it to the Council at its next meeting, the study to include fellowship problems besetting institutions. Dean Everitt was instructed to request the courtesy of holding the check for $3000 until the Council comes to a firm decision.

10. *Report of ECRC Activities*

Copies of the report submitted to the Executive Board and made a part of its minutes of June 20 and 22, 1955 were distributed to all present.

Dr. H. K. Work, Vice President and Chairman of ECRC, stated the *Review of Current Research* would be available in July and that the book on "Creativity In Research" is progressing. Also, the committee on Research Administration is making a study of overhead costs, how research personnel are handled with respect to tenure, etc.

The desirability of establishing an ECRC award, consisting of a gold medal, for outstanding research was presented. It was proposed that outside funds be obtained, but if none were available in time for the 1956 award, the needed money was to come from the ECRC reserve. The Council *VOTED* to approve the establishment of such an award.

Dr. Work presented the recommendation of the Executive Board that, "Funds be solicited from the National Science Foundation to determine the research needs of the Engineering Sciences and how the needs shall be met." About $40,000 is needed for the two-year study which is to be an ASEE project directed by

the personnel of ECRC. The proposed budget is attached hereto as Appendix E.

11. *Report of Divisions and Committees*

a. *Ethics.* Dean C. J. Freund, Chairman of the Committee, reported that work is progressing toward a future preparation of a manual which would be in the nature of a case book illustrating the Canons of Ethics. A written report was submitted and a copy is attached as Appendix F.

b. *YET.* Professor P. Weinburg, Chairman of the Committee submitted a written report, a copy of which is submitted as Appendix G. In the discussion it was agreed the YETs will again conduct a membership campaign, including physicists as well as other groups not falling into the engineering curricula category, but which are involved in the teaching of engineers and which are represented in ASEE. It was further agreed the President should aid the YETs by extending a personal letter of invitation to join.

The Council *VOTED* to implement Recommendation No. 5 of the Report by authorizing the President to appoint a committee to study the question of having summer schools, planned by the Educational Methods Division and CYET, preceding the Annual Meetings and having a theme stressing pedogogical matters.

c. *Atomic Energy Education.* Chairman P. N. Powers submitted a written report attached hereto as Appendix H. Mr. Powers requested that his committee be authorized to make a comprehensive study to follow the pattern of Evaluation of Engineering Education. Finances would need to be adequate to permit the committee and the necessary sub-committees to meet as required and to permit visits to engineering colleges. The general areas of study would be:

(1) Immediate and future requirements for men with training in the nuclear field.
(2) Undergraduate, graduate, and special programs to aid in the development of engineers in the nuclear field.
(3) The part colleges and universities should play.
(4) The long-term role of training programs in Government Laboratories such as Argonne and Oak Ridge.

The study group would cooperate with other agencies such as the Atomic Energy Commission, colleges and universities offering programs in nuclear engineering, industrial organizations, EJC, etc. The estimated budget is $20,000. The Council *VOTED* to endorse the proposed study, authorize the committee to proceed with its plans, and authorize the Society to lend its support to the procuring of funds.

d. *Honorary Membership.* No report.

e. *Constitution and By-Laws.* Chairman H. O. Croft presented a written report to all present outlining changes in Article II, Section 2, 3, 5, and 6. The report is attached hereto as Appendix I. The Council *VOTED* unanimously to approve the changes as contained in the report. It was agreed the changes be submitted immediately for ECAC and ECRC approval.

The Committee recommended no changes in regard to:

(1) Article IX, Section 3. "Papers and discussions presented before Sections or Branches shall be the property of the Society . . ."
(2) Article II, Section 4. "A member in good standing may become a life member, . . . by a single payment of an amount equal to twenty times the annual dues for members. Such payments . . . shall be placed in a separate fund known as the Life Membership Fund. . . ."

The Council *VOTED* to appoint an *ad hoc* committee to study the problem of ownership of papers as stated in (1) above and report to the Council at its next meeting.

f. *Society Functions.* The Council *VOTED* approval of the Executive Board's recommendation that the name

and boundaries of the Upper New York Section be changed to Upper New York-Ontario Section so as to include the University of Toronto and Queen's University.

Dean B. R. Teare, Jr., Chairman of the Committee, outlined some of the questions being considered by his committee and stated he hoped agreements could be reached at a special two-day meeting to be held during the Summer. The Council *VOTED* approval to the addition of $1000 to the budget to finance the special meeting.

g. *Technical Institute Division.* C. J. Jones, Chairman of the Division, presented the need for a book telling of the work of the technical institute and the place of its graduates in industry. A. L. Williston wishes to make an initial gift to the Society of securities, valued at $6000 but to be sold by the Society, for defraying expenses involved in preparing the book. It was further suggested that a committee be appointed to prepare the book, that the Society administer the funds in a manner similar to that followed for other projects, and that the copyright be in the name of the Society. The Council *VOTED* to approve the appointment of a committee by the President, to accept the securities presented for conversion to cash, and that the committee be reimbursed for its expenses in accordance with the established practice of the Society.

h. *Degree Designations.* In the absence of the Chairman, H. P. Rhodes read the report. Since the portions dealing with Honorary Doctorates and Associate degrees for Technical Institutes were not clear, the Council *VOTED* to receive the report and refer it back to the Committee for clarification and resubmission to the Council at its next meeting.

i. *Financial Policy.* Dean W. R. Woolrich, Chairman of the Committee, submitted a written report, a copy being attached hereto as Appendix J. The Council *VOTED* that the report be filed.

12. *Annual Meeting Guide*

The Secretary reported that Professor J. C. Reed had submitted 100 mimeographed copies and that copies were being made available to Annual Committee members at Iowa State and Cornell.

13. *EJC Constitution Changes*

The Executive Board recommended to the Council that the changes be approved. The Council *VOTED* to approve the amendments as previously passed by other constituent societies.

14. *ECPD Membership for NSPE*

There seemed to be some confusion regarding ASEE action. Since a committee is now studying the problem of enlarging ECPD, it was agreed the Council should await the report of the committee.

After this action President Dougherty reviewed past minutes of the Executive Board and reported on June 24 that a resolution was passed recommending extending an invitation to NSPE providing necessary approval was met, meaning that the invitation was not to be extended unless approved by the various Societies which are members. The Council *VOTED* to concur in the recommendation of the Executive Board.

15. *Future Annual Meetings*

The Secretary reported the following location and dates for future Annual Meetings:

1956 Iowa State.....June 25–29
1957 Cornell.....June 17–21

16. *Other Business*

a. *Report on General and Regional Activities.* Vice President B. R. Teare, Jr., briefly reported and stated the general position of the Sections was good, but that there was a real need for continuity of programming between Section Meetings and the Annual Meetings. Copies of his report to the Executive Board, and attached to its minutes of June 20, 1955 as an Appendix, were distributed to all present.

b. *Report on Instructional Division Activities.* Vice President L. J. Lassalle dis-

tributed copies of his report to the Executive Board, and attached the minutes of June 20, 1955, as an Appendix, to all present.

c. *AAAS Science Teaching Emergency Program.* J. A. Behnke, Associate Administrative Secretary of AAAS made an appeal for help in recruiting teachers for high schools, because better teaching of science and mathematics there directly influences the work of colleges of engineering. Of particular interest is the group of students dropping out of engineering and entering some other area of study. The 7-point program for improving science teaching was briefly outlined and a plea was made for suggestions and help in making their 3-year plan effective. The Carnegie Foundation is contributing $300,000 to put the program into effect.

d. *Summer Schools for 1956.* The Council *VOTED* to approve the requests for Summer Schools received from:

Mechanics Division
Humanistic-Social Division
Engineering Drawing Division
Civil Engineering Division

Approval of the host institution, Iowa State College is also a requirement for the holding of a Summer School.

e. Professor A. J. McNair, Chairman of the Civil Engineering Division, requested approval of a joint membership committee for purposes of certification of Sanitary Engineers in cooperation with:

American Society of Civil Engineers
(The sponsoring and financing organization)
American Public Health Association
American Water Works Association
Federation of Sewage and Industrial Wastes Association.

The Council *VOTED* authority to the President to appoint one to three members to the committee.

f. *Henry S. Jacoby.* President Dougherty stated Henry S. Jacoby, our oldest living past president, was one hundred years old. The Council *VOTED* that the Secretary send him a telegram of congratulations and extend the best wishes of the Society.

g. *Resolutions.* Dr. H. H. Armsby, Chairman of the Resolutions Committee, submitted a copy of the resolution presented at the Annual Banquet. A copy is attached as Appendix K.

17. *Next Meeting*

The Council *VOTED* that the next meeting be with the meeting of the Association of Land Grant Colleges and Universities being held at Michigan State on November 15, 16, and 17. The Secretary is to work out the details of time and place.

18. The meeting finally adjourned.

Respectfully submitted,
W. LEIGHTON COLLINS,
Secretary

Marquette College-Industry Conference

A College-Industry Conference will be held at Marquette University, January 25 and 26 to help celebrate the 75th anniversary of Marquette University. The theme of the meeting will be "The Humanistic-Social Approach as an Aid to Engineering."

• • • YET-ITUDES*

• *yelps and helps for the young engineering teacher*

Contributed by CYET
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A Higher Degree YET!

By MERL BAKER

Professor of Mechanical Engineering, University of Kentucky

The young teacher in engineering may ponder the potential value that a *thirty minute* reading knowledge of German or French would be to his class room teaching. The value of advanced mathematics in teaching an elementary course in heat power or theoretical physics for machine design may seem ridiculous. Some reason that the requirements of the Ph.D. are predominantly research and hours of midnight work, and that the training contributes little to a person's ability to teach undergraduate classes. It is true that some individuals have "died from the shoulders up" after receiving the Ph.D. and it becomes void of intellectual integrity and serves only as an asset to stimulate undeserved promotions and recognitions. Obviously, these individuals do not use the degree to the advantage of their students.

When or if a clear understanding of how a student learns is gained, the teacher becomes immediately aware of the fact that teaching is far more than lecturing, grading papers and giving examinations. The teacher must participate in some type of personal creative activity if he is to motivate his students, which might be writing, research, counselling, curriculum improvement, or committee activities. The pursuance of advanced degrees, especially the Ph.D., affords an excellent opportunity for individual creativity and for this reason, work associated with earning the degree will contribute immeasurably to good teaching.

Some younger teachers are discouraged from seeking advanced degrees because of the "decaying sap" progressively observed in some holders of the degree; others feel that they had rather "hear themselves lecture" than to be exposed to (and indoctrinated with) the thoughts of someone else (the skeptic), while probably by far the larger portion appreciate the value of the degree and are capable of earning it, but do not have the *financial* resources for pursuance (the realist). This obstacle can be minimized.

The July 1955 Quarterly Report of the Carnegie Corporation has an excellent report entitled "Wanted: Teachers

*"YET-itudes" is devoted to informing the Society of the needs, pleads, and deeds of the young engineering teacher. The potential of ASEE lies with the young engineering teacher. The CYET feels you should be informed of how much "fire is in the furnace."

YET-itudes! Not Platitudes!

and Scholars." It is one thing to teach and another to teach *well.* This report discusses the Woodrow Wilson Fellowship Program in the humanities and social sciences. Fellowships are provided on a competitive basis for B.S. graduates desiring to follow teaching as a profession. The program is supported by contributions from graduate schools and foundations.

Why not an effective fellowship plan for our young engineering teachers? There is much evidence to support such a plan as an effective way to improve the quality of engineering education.

Who should support the program financially? As *industry* profits most from well qualified engineering graduates, its support of a fellowship program would seem to be a good investment and not merely a contribution. The employer institution should consider its gain by supplementing the individual's stipend through leaves of absence with part pay. In addition such a plan should fit into the program of educational foundations. Does the young engineering teacher have time to pursue advanced degrees if he were awarded a fellowship? By working full time on the degree, the time required will be greatly reduced over that required were he to earn a living, allowing him to return to his job in a reasonable time.

An active program to assist our many capable young engineering teachers to pursue graduate work, should pay rich dividends in retaining an adequate number of teachers in the engineering schools in addition to improving the quality of teaching. The program must be initiated on a local basis by individual institutions or collectively by ASEE. Educational programs initiated and supported by a particular industry for its employees would not meet the need. Too many young teachers would fail to return to the class room after "grazing on the green pastures of industry."

Let's seek better future engineering graduates by helping our teachers now.

* * *

Here is your November YET-itude: It takes one to train one.

THE T-SQUARE PAGE

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Is Engineering Graphics a Science?

By MATTHEW McNEARY
Professor of Engineering Graphics, University of Maine

In the January, 1955, issue of the *Journal of Engineering Education,* an article appears entitled "ECPD Accreditation of Fringe Curricula" which contains more than the title suggests. Included in this article are rather specific recommendations for the accreditation of "major" curricula. There is no mention in these recommendations of the expected role of engineering graphics (or engineering drawing, if you prefer) in the curriculum of the future. If we are to educate only pure scientists this omission is understandable, though regrettable. If, however, we are to educate engineers the situation may be much more serious. To remedy this, I suggest that engineering graphics be listed by the ECPD as one of the engineering sciences basic to engineering education.

Let us examine the requirements recommended by the ECPD for accreditation of "major" curricula. Summarizing very briefly, and taking some small liberties with the text, a "major" curriculum shall be recommended for accreditation when it meets the following criteria:

1. *One year* devoted to mathematics and *basic sciences,* equally divided.
2. *One year* devoted to *engineering sciences,* including at least six of the following: statics; dynamics; strength of materials; fluid flow; heat flow; thermodynamics; electrical circuits, fields, and electronics; engineering materials; physical metallurgy.
3. *One-half year* devoted to engineering analysis, design and engineering systems.
4. An appropriate portion (*usually about three-fourths of a year*) devoted to humanistic and social studies.

Adding up the years required for the foregoing items, we find that three and one-fourth of the four years are consumed, and no mention of engineering graphics. This leaves three-fourths of a year for courses which cannot find a place in the listed categories. Competition will be keen among specialized and applied courses for this space. It is vital for engineering education that engineering graphics, a subject used by all engineers in one form or another, not be forced to find its place among the miscellany of college offerings. To accomplish this, engineering graphics should be recognized as a science.

The matter of determining one's position in this scheme of things is largely a matter of semantics, the meaning of words. What is a science? Webster's Unabridged Dictionary gives the following definitions of the word "science":

1. Knowledge; knowledge of principles or facts.

2. Specific, accumulated and accepted knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws; knowledge classified and made available in work, life, or the search for truth; comprehensive, profound, or philosophical knowledge.
3. Especially such knowledge when it relates to the physical world and its phenomena.
4. Any branch or department of systemized knowledge considered as a distinct field of investigation or object of study.
5. Art or skill regarded as the result of knowledge of laws and principles.

Not one of these definitions could be construed so as to exclude engineering graphics from the sciences. The fact that we teach *some* technique does not make us different from the basic sciences which use laboratory instruction in part. In physics, for instance, there is laboratory instruction in measurement, and it is reasonably sure that the student is not told that he may use the micrometer carelessly or write a slip-shod report for fear that he may become a technician. The teaching of technique, or teaching by the laboratory method, does not preclude a subject from being a science.

Surely engineering graphics teaches a body of "accumulated and accepted knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws." Orthographic projection enables the engineer to represent three-dimensional objects on the two-dimensional surface of a sheet of paper. As a means of communication and a vehicle for design it has made possible much of the technical progress that has been made and will be made. The principles of projection have been accumulated, accepted, systematized, and formulated since the beginning of the nineteenth century, and the general laws of this phase of graphics are used daily by most engineers, particularly those who are engaged in *creative* work. It should be kept in mind that orthographic projection is used not only for delineation, but also for spatial problem-solving as an adjunct, and frequently a superior method, to numerical calculation. As taught by a progressive graphics department, engineering graphics is a rigorous discipline and a creative experience for the young engineering student.

Only those who judge subjects by long past experience and who neglect to inquire into what is being taught today fail to realize that the nature of engineering graphics instruction has changed radically in the last twenty years. How many engineering educators who are busy in other fields know that the descriptive geometry of the present day is far different and more useful than the subject they once learned? Are they aware that technique, while not neglected, is not emphasized to the time-consuming extent that it once was? Do they know that graphical mathematics is under continual investigation and is being taught in many of our colleges in basic graphics courses? Few fields of study can take comparable pride in their achievement and progress.

To sum up, engineering graphics is a fundamental, long-established, and growing science,—an engineering science worthy in importance to stand beside subjects such as strength of materials, fluid flow, physical metallurgy, etc., which are now in the ECPD list. If engineering education is to continue to be well-grounded, and creativeness to be encouraged, it should appear on the ECPD list under "Engineering Sciences." (Notice of the Mid-Winter Meeting of the Engineering Drawing Division may be found on page 235.

Teaching Positions Available

The following rules were adopted by the General Council of the ASEE:

The privilege of advertising for teaching positions is extended only to colleges and technical institutes which are either Active or Affiliate Institutional Members of the ASEE. Advertisements must be for positions available only. No advertisements will be accepted for an individual seeking a job.

Advertisements must be submitted not later than the first day of the month preceding the month of issue. Because of limited staff, the ASEE headquarters cannot maintain personnel files or supply detailed information about jobs. In replying to blind ads, address letters to American Society for Engineering Education, University of Illinois, Urbana, Illinois and give blind ad number. Information and rates for advertising in the Journal can be received by writing ASEE Headquarters. In order to conserve space and achieve uniformity, the privilege is reserved to rearrange advertisements.

INSTRUCTOR OR ASSISTANT PROFESsor of Engineering to teach Mechanical Drawing and Plane Surveying at a branch college of the University of Virginia. Rank and salary dependent upon education and experience. Apply Dean of Engineering, Thornton Hall, University of Virginia, Charlottesville, Va.

INSTRUCTOR OR ASSISTANT PROfessor of Civil Engineering. Teaching experience desirable but not necessary. B.S. or M.S. in Civil Engineering required. Salary and academic rank commensurate with degree and experience. Contact Civil Engineering Department, University of Denver, Denver 10, Colorado.

PROFESSOR (ASSISTANT, ASSOCIATE, or full rank). Candidate should have M.S. degree; experience with High Frequency very desirable. Teaching Assignments: Basic Electronics, Communications and fundamental electrical engineering courses. Rank and salary will depend upon experience and training. School located on a large campus in Northwestern Detroit. Cooperative program. Position open for term starting either November 20, 1955, or February 21, 1956. NOV-1

STAFF OPENINGS IN CIVIL ELECtrical, and Mechanical Engineering; MS or PhD's desired. Salaries commensurate with qualifications. College of Engineering, Duke University, Durham, North Carolina.

ASSISTANT PROFS. OF MECH. ENGR. organize and teach courses in production processes, thermo. or drawing and design. 3 positions open Feb. 1. M.S. degree required. New building and equipment; good salary schedule. Write: Engr. Dept., San Jose State College, San Jose, Calif.

ELECTRICAL ENGINEERING POSItion to teach undergraduate courses. Ph.D. preferred, M.S. acceptable. Opportunity for graduate study, industrial consulting or research. Rank and salary open. Start February or September 1956. University of Santa Clara, Santa Clara, California.

ENGINEERING FACULTY OPPORTUnity at midwest state college. The Chairman in the Physics Department, salary open. Electrical Engineering Instructor or Assistant Professor in the Power field. Mechanical Engineering Instructor or Assistant Professor in Physics. Opportunity for graduate study. Housing available. Positions start September, 1956. NOV.-2

ASSISTANT PROFESSOR AND INstructor at small midwest engineering college in the Civil Engineering Department. Positions for spring or fall semester, 1956. Assistant professor must have special training or experience in sanitary engineering. Must have broad interests as applied mechanics and strength of materials as well as civil engineering are taught. Opportunity for graduate study at nearby university. NOV-3

New Members

ARNBAL, CARL ANTON, Assistant Professor of Engineering Drawing, Iowa State College, Ames, Iowa. James S. Rising, M. W. Almfeldt.

BAKER, JR., CARY FORNEY, Editor, Technical Education Department, McGraw-Hill Book Company, Inc., New York, New York. Jeanne I. Miller, H. Walter Shaw.

BAKER, PERLEY D., Dean of Norwich University, Northfield, Vermont. W. Leighton Collins, T. J. Dolan.

BOBCO, RICHARD PHILLIP, Instructor of Mechanical Engineering, Colorado School of Mines, Golden, Colorado. Albert L. Gosman, Hilbert F. Fletcher.

BOYD, JAMES STERLING, Associate Professor of Agricultural Engineering, Michigan State University, East Lansing, Mich. Carl F. Albrecht, Chester J. Mackson.

BRYANT, P. JOHN, Editor, General Motors Engineering Journal, General Motors Corporation, Detroit, Mich. Kenneth A. Meade, J. C. McElhany.

BURKE, PATRICK EARL, Lecturer in Electrical Engineering, University of Toronto, Toronto, Ontario, Canada. Adam J. Kravetz, Gordon F. Tracy.

CLELAND, SAM M., Associate Professor of Engineering, A. & M. College of Texas, College Station, Texas. W. E. Street, John P. Oliver.

DARLING, RAYMOND O., Associate Editor, General Motors Engineering Journal, General Motors Corporation, Detroit, Michigan. Kenneth A. Meade, J. C. McElhany.

ESSLER, WARREN ORVEL, Instructor in Electrical Engineering, South Dakota State College, College Station, South Dakota. K. F. Lindley, William J. Streib.

FIFE, JOHN PRESTLEY, Head of Humanities, Stevens Institute of Technology, Hoboken, N. J. Jess Harrison Davis, Lynn Merrill.

FOSTER, FRANKLIN LEROY, Director of Division of Industrial Cooperation, Massachusetts Institute of Technology, Cambridge, Mass. Arthur L. Townsend, Carl L. Svenson.

FROSLIE, HAROLD M., Head of Physics Department, Acting Engineering Dean, South Dakota State College, College Station, Brookings, South Dakota. Emory E. Johnson, Lee L. Amidon.

GARY, JAMES HUBERT, Assistant Professor of Chemical Engineering, University of Virginia, Charlottesville, Va. Lawrence R. Quarles, Orville R. Harris.

GLENN, CARROLL J., Executive Assistant to the Deans, St. Louis University of Technology, Saint Louis, Mo. Ross R. Heinrich, James B. Macelwane.

GOLDSTEIN, IRVING ROBERT, Associate Professor of Management Engineering, Newark College of Engineering, Newark, New Jersey. Olive J. Sizelove, William J. Jaffe.

GOMBERG, HENRY JACOB, Professor of Nuclear and Electrical Engineering, University of Michigan, Ann Arbor, Michigan. W. J. Emmons, George G. Brown.

GRANT, LEROY FRASER, Field Secretary, Engineering Institute of Canada, Kingston, Ontario, Canada. Maynard M. Boring, Thorndike Saville.

HANKINSON, GEORGE WILLIAM, Associate Professor in Civil Engineering, Northeastern University, Boston, Mass. Emil A. Gramstorff, W. T. Alexander.

HIPSH, HAROLD M., Professor and Head of Aeronautical Engineering, The Pennsylvania State University, University Park, Pa. Gerald K. Gillian, Jerome Steffens.

HORVIK, EIVIND, Acting Head of Physics Department, North Dakota State College, Fargo, North Dakota. Frank C. Mirgain, Robert N. Faiman.

HUANG, EUGENE YUCHING, Research Assistant Professor of Civil Engineering, University of Illinois, Urbana, Illinois. Ellis Danner, Thomas C. Shedd.

HUDSON, JACK L., Co-ordinator, College Co-op Training in the Technical Training Department, Chrysler Corporation, Detroit, Michigan. Donald C. Hunt, Earl C. Flarity.

JACKSON, JR., CHARLES ORLAND, Engineering Professor Placement Representative, Ford Motor Company, Dearborn, Michigan. Arthur L. Townsend, Carl L. Svenson.

KERR, ROBERT B., Instructor in Electrical Engineering, Johns Hopkins University, Baltimore, Md. John L. Artley, Robert H. Roy.

KOMMIT, DANIEL L., Instructor in Mechanical Engineering, New York University, New York, N. Y. Austin H. Church, Fred H. Posser.

LABENSKI, JOHN JOSEPH, Associate Professor Ordnance Research Laboratory, The Pennsylvania State University, University Park, Pa. Arnold Addison, Edward J. Tracey, Jr.

LANGSAM, WALTER CONSUELO, President of the University of Cincinnati, Cincinnati, Ohio. C. A. Joerger, H. K. Justice.

LARKIN, WILLIAM HARRISON, Engineer, Air Preheater Corporation, New York, N. Y. Newell L. Freeman, N. S. Hibshman.

MANZ, OSCAR ERNEST, Assistant Professor of Geology, University of North Dakota, Grand Forks, North Dakota. E. L. Lium, Robert J. McFarlin.

MOSILLO, FRANCIS ANTHONY, Instructor in General Engineering Drawing, University of Illinois (Chicago, Navy Pier), Chicago, Illinois. E. J. Caldario, M. V. J. Dembski.

OLIVER, JAMES H., Commercial Engineer, User Industries Sales General Electric Company, Schenectady, N. Y. W. H. Branch, D. Lee Chestnut.

OLSEN, CHARLES EUGENE, Instructor of Mathematics, University of Illinois, Chicago Branch, Chicago, Illinois. L. N. Blair, M. V. J. Dembski.

PAAPE, CHARLES WILLIAM, Associate Professor of History, Carnegie Institute of Technology, Pittsburgh, Pa. W. Leighton Collins, T. J. Dolan.

PETERS, RALPH EDWARD, Aeronautical Engineering Coordinator, University of Cincinnati, Cincinnati, Ohio. H. C. Messinger, Bradley Jones.

PETERSON, THOBURN FINDLEY, Assistant Professor of Engineering Drawing, University of North Dakota, Grand Forks, North Dakota.

ROHSENOW, WARREN M., Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Bonnie-Blanche Schoonover, Arthur L. Townsend.

ROSS, C. HUDSON, Associate Professor, Clarkson College, Potsdam, N. Y. W. H. Allison, Charles N. Henshaw.

SALINE, LINDON E., Regional Manager-Headquarters Recruiting, General Electric Co. —Bldg. 69, Schenectady, New York. W. Scott Hill, Henry G. Hutton.

SEID, ROBERT BERNARD, Instructor of Engineering Drawing and Descriptice Geometry, Queens College, Flushing, New York. L. O. Johnson, Irwin Wladaver.

Stinson, JAMES R., Instructor in Geophysics and Geophysical Engineering, St. Louis University Institute of Technology, Saint Louis, Missouri. Ross R. Heinrich, James B. Macelwane.

STURROCK, WALTER, Illuminating Engineer —Large Lamp, General Electric Company, Cleveland, Ohio. M. M. Boring, Russell C. Putnam.

TINETTI, GEORGE KENYON, Machine Shop, General Motors Institute, Flint, Michigan. C. L. Fanning, F. L. Mackin.

TINKER, ROBERT NORMAN, Assistant Professor of Engineering Drawing, Rose Polytechnic Institute, Terre Haute, Indiana. Ralph M. Ross, Herman A. Moench.

VANNAH, SHERMAN, Associate Professor of Mechanical Engineering, Tufts University Medford, Massachusetts. Kenneth N. Astill, Edgar MacNaughton.

VONDERLAGE, FRED C., Director, Oak Ridge School of Reactor Technology, Oak Ridge National Laboratory, Oak Ridge, Tenn. W. Leighton Collins, Maynard M. Boring.

WAINES, RUSSELL TALBOT, Assistant Professor of Mechanical Engineering, University of Toronto, Toronto, Ontario, Canada. Irvine W. Smith, W. G. McIntosh.

WANG, SHOU-LING, Assistant Professor of Civil Engineering, Clarkson College of Technology, Potsdam, New York. W. H. Allison, Preston W. Smith.

WILLIAMS, GEORGE LOUIS, Instructor of Physics, Newark College of Engineering, Newark, New Jersey. Thomas J. Blisard, Paul O. Hoffman.

WOLFE, JOHN K., Manager, Advance Degree Personnel, General Electric Company, New York, New York. M. M. Boring, W. Scott Hill.

YOUNGMAN, LESTER A., Associate Professor of Physics and Engineering, Pan American College, Edinburg, Texas. W. Leighton Collins, W. M. Lansford.

51 New members this list
111 Previously added

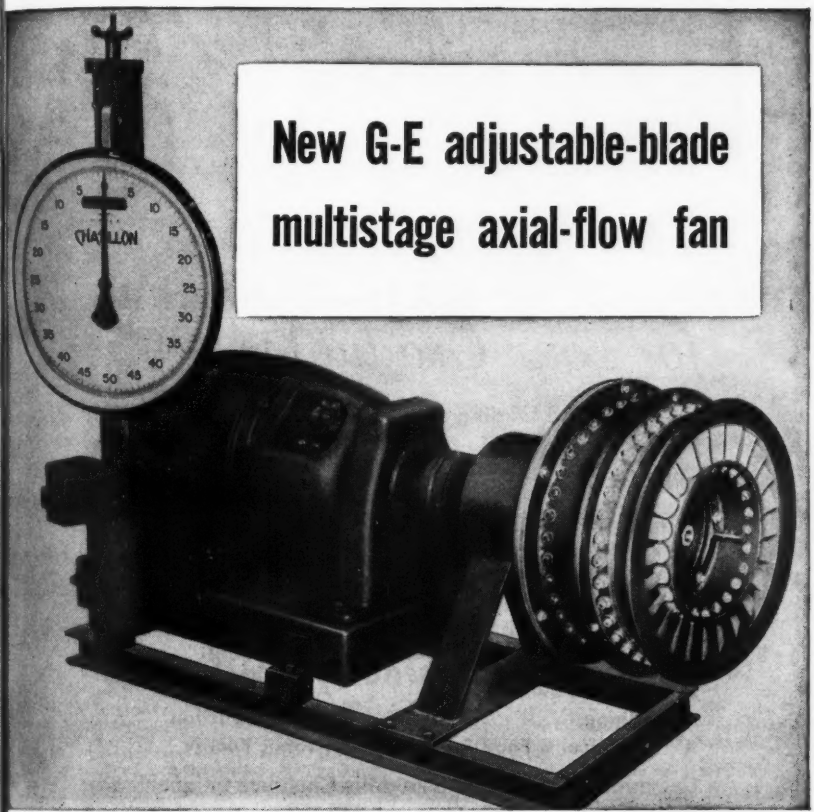
162 New members this year

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Carnegie Institute of Technology	April, 1956	J. W. Graham, Jr., Carnegie Institute of Technology
Illinois-Indiana	Purdue University	May 12, 1956	O. W. Witzell, Purdue University
Kansas-Nebraska	University of Nebraska	Oct. 22–23, 1955	J. K. Ludwickson, Kansas State College
Michigan	Wayne University	May 6, 1956	G. H. Howell, Wayne University
Middle Atlantic	New York University	Dec. 3, 1955	C. C. Carr, Pratt Institute
Missouri-Arkansas	St. Louis University	April 7, 1956	J. B. Macelwane, St. Louis University
National Capital Area	Capital Radio Engineering Institute	Oct. 11, 1955	D. C. Jackson, Jr., Aberdeen Proving Ground
New England	University of Maine	Oct. 8, 1955	W. S. Davis, University of Maine
North Midwest	South Dakota State College	Nov. 4–5, 1955	L. L. Amidon, South Dakota State College
Ohio	Ohio State University	April 28, 1956	E. C. Clark, Ohio State University
*Pacific Northwest			J. B. Morrison, University of Washington
Pacific Southwest	California Institute of Technology	Dec. 28–29, 1955	R. G. Moses, Pasadena City College
*Rocky Mountain	Denver University		W. H. Parks, University of Denver
Southeastern	Tulane University	April 5, 6, 7	D. W. Dutton, Georgia Institute of Technology
Southwest	Texas Western College	March 30–31, 1956	H. K. Bone, University of Oklahoma
Upper New York-Ontario	Syracuse University	Oct. 14–15, 1955	B. H. Norem, Syracuse University

Members of the Society are welcome at all Section Meetings

*** No Date Set.**



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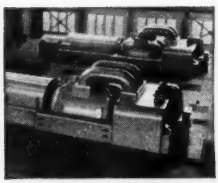

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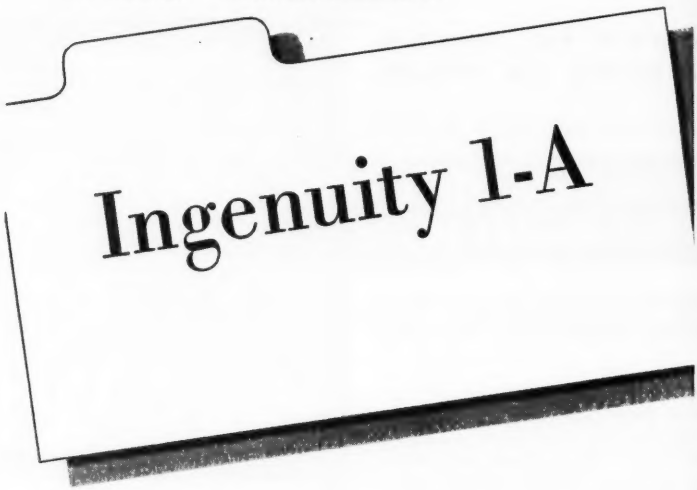

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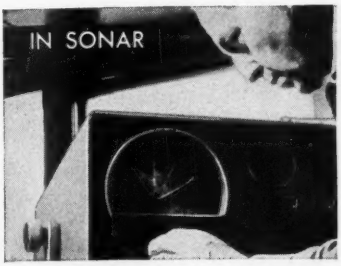

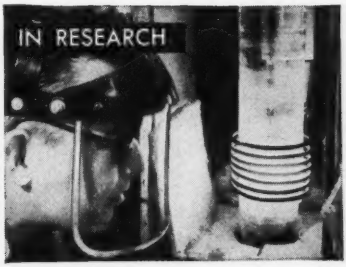

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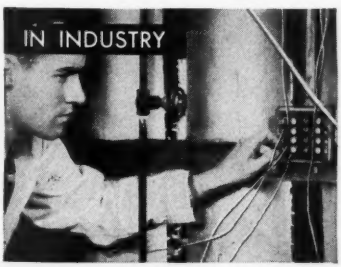

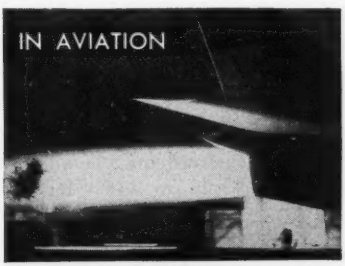

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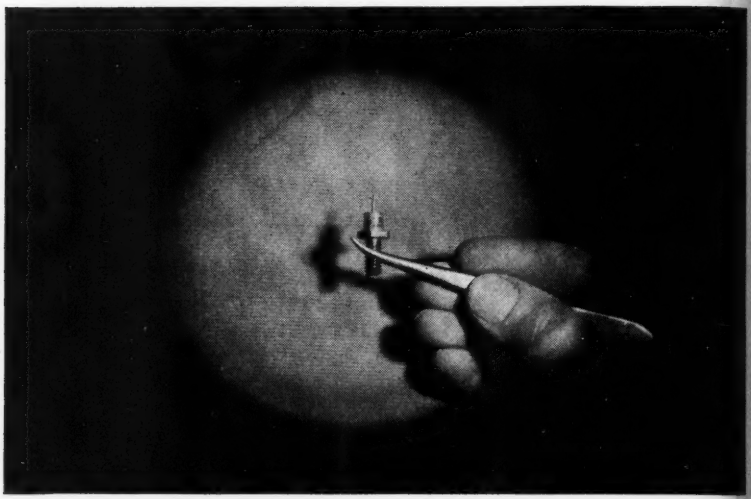
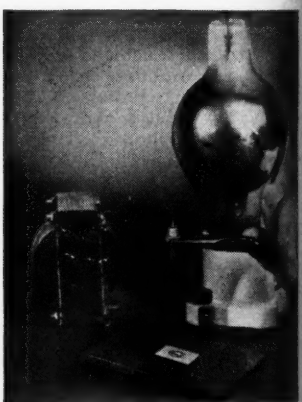


Telephone science produces an important new rectifier

At Bell Laboratories one line of research is often fruitful in many fields. Latest example is the silicon power rectifier above.

Product of original work with semi-conductors—which earlier created the transistor and the Bell Solar Battery—the new rectifier greatly reduces the size of equipment needed to produce large direct currents. It is much smaller than a tube rectifier of equal performance. It does not require the bulky cooling equipment of other metallic rectifiers.

In the Bell System the new rectifier will supply direct current more economically for telephone calls. It can also be adapted to important uses in television, computers, industrial machines, and military equipment. Thus, Bell Telephone Laboratories research continues to improve telephony—while it helps other fields vital to the nation.



Above, new rectifier (held in pliers) is contrasted with comparable tube rectifier and its filament transformer, rear. Mounted on a cooling plate, lower center, the new rectifier can easily supply 10 amperes of direct current at 100 volts, that is, 1000 watts—enough to power 350 telephones.

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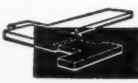

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